Water

P.E.I.'s MOST PRECIOUS RESOURCE

ACTIVITIES AFFECTING SURFACE WATER RESOURCES

A GENERAL OVERVIEW

SURFACE WATER PROGRAM

MARCH 1990

THE CANADA–PRINCE EDWARD ISLAND
WATER MANAGEMENT AGREEMENT

Environment Canada Environnement Canada

Prince Edward Island
Department of the Environment

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Environment Canada
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P.E.I. Department of the Environment
Fish and Wildlife Branch

SURFACE WATER PROGRAM

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PREFACE

This report is a result of the Canada - Prince Edward Island Water Management Agreement. It was produced by the Watershed Inventory Project as part of the Surface Water Program to provide a better understanding of the activities which may affect the quality and quantity of surface waters on Prince Edward Island.

Inventory reports are also available for major watershed complexes across the Island. This report is intended to be used in conjunction with the individual watershed reports and the book of specific watershed complex inventory maps which are on file at Inland Waters Directorate, Environment Canada in Dartmouth, Nova Scotia.

Mapping is performed on the 1:50,000 N.T.S. topographical series using the Universal Transverse Mercator (U.T.M.) grid system to the nearest one hundred (100) metres for point data. Non-point (polygon) data is also mapped where applicable. This mapping technique is easily transferable to the Geographical Information System (G.I.S.) which provides for updating and manipulation of the data.

ACKNOWLEDGEMENTS

The co-chairmen of the Surface Water Program wish to acknowledge the efforts of those people who were involved in the preparation of this report:

Bryan M. Pellerin, Personal Services Contractor, Inland Waters Directorate, Environment Canada;

Don B. Reeves, Fish and Wildlife Branch, P.E.I. Department of Community and Cultural Affairs;

T. Kent MacRae, Fish and Wildlife Branch, P.E.I. Department of the Environment;

Kelly Taylor, Personal Services Contractor, Inland Waters Directorate, Environment Canada who performed the illustrations and carried out the derivation of the physiographic parameters and mapping of the inventoried activities;

R. G. Howatt, Water Planning and Management Branch, Inland Waters Directorate, Environment Canada, Dartmouth, N.S. for preparation of graphics for report publication, and

Alan P. Godfrey, Project Manager, Fish and Wildlife Branch, P.E.I. Department of the Environment.

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1.0 INTRODUCTION

In November 1987, Prince Edward Island (P.E.I.) became the first Canadian province to sign a Federal/Provincial work-sharing arrangement on water resource management. The three-year $1 million Canada-Prince Edward Island Water Management Agreement will focus upon several areas including; groundwater pollution, surface water degradation and estuarine eutrophication. Of these, the Watershed Inventory Project under the Surface Water Program has been designed to identify current surface water uses and users within twelve major watersheds across the Island (Figure 1.1) containing twenty-six (26) individual rivers. Problems arising due to practices that degrade the quality of surface water and restricts its value for other user groups will also be determined. The watersheds being inventoried in order of priority are;

1. Hillsborough River Watershed Complex;
2. Dunk - Wilmot Rivers Watershed Complex;
3. Mill - Trout Rivers Watershed Complex;
4. Boughton - Fortune Rivers Watershed Complex;
5. Murray River;
6. Brudenell - Cardigan Rivers Watershed Complex;
7. Montague - Valleyfield Rivers Watershed Complex;
8. St. Peters Bay Watershed Complex;
9. Rustico Bay Complex;
10. Tracadie Bay Complex;
11. New London Bay Complex; and the
12. Brackley - Covehead Bay Complex.

Agricultural, wildlife, forestry, recreational, fisheries and industrial parameters were examined during the course of the Project. As well, individual reports written for each of the study watershed complexes will provide more detailed information concerning selected parameters and sites.

Under agreement with the Forestry Branch, P.E.I. Department of Energy and Forestry, both point and non-point (polygon) data will be entered on a Geographical Information System (G.I.S.). This will assist in facilitating the development of a multipurpose land information system and allow for the drafting of an extensive series of maps to accompany the written reports.

This exercise represents an important first step toward establishing a comprehensive and detailed database which will assist in future watershed management and maximize economic benefits from P.E.I.'s surface water resources.

Figure 1.1 Watersheds Under Study

2.0 GENERAL CHARACTERISTICS OF PRINCE EDWARD ISLAND

2.1 Geology of Prince Edward Island

Prince Edward Island forms part of the Maritime Carboniferous Basin. Beginning some 220-300 million years ago, and continuing for more than seventy-five (75) million years, this lowland region or plain received massive accumulations of eroded material from the surrounding highlands. Brown and cloudy with sand, silt and gravel, ancient rivers drained these areas that presently form western Nova Scotia and parts of New Brunswick, Quebec and Newfoundland (Mullen and Evans, 1979). P.E.I. was formed as a result of this deposition as well as tectonic upheaval which elevated the Island above sea level.

Today, a mantle of loose material known as glacial till, laid down 10,000 to 15,000 years ago, covers much of the Island. The underlying sedimentary bedrock consists of soft red sandstone intermixed with shale. Rock exposures are predominately sandstone with lesser amounts of siltstone, claystone and conglomerate also present. The only outcropping of rock found on P.E.I. is on the northeast tip of Georges (Hog) Island which is located in northern Malpeque Bay.

2.2 Physiography

Prince Edward Island's landscape has been largely influenced by the shape of the bedrock and by the ease with which it has been eroded. Low cliffs predominate along much of the shoreline. Especially on the northern headlands, these cliffs have eroded to produce sediments that contribute to the formation of offshore and baymouth bars, sand dunes and spits. Annual shoreline retreat of more than thirty (30) centimetres is normal and up to four metres has been recorded (Betts, 1989). The southern coastline, however, is more protected and erosion is, therefore, less pronounced.

The several glaciers which once covered P.E.I. resulted in a nearly level to gently rolling landscape over much of the province. Approximately three-quarters of the land area is less than fifty (50) metres above sea level, but a few hills throughout the central section of the Island have elevations of one hundred and fifty (150) metres.

The province is traversed by an extensive network of freshwater streams and rivers. Often wide and relatively shallow, many of these rivers experience a tidal influence over much of their length. Extensive salt and freshwater wetlands are associated with several of the larger rivers. There are also several small lakes and ponds occurring throughout the Island.

For the most part, topography determines land use and a mosaic of farmland and forest carpets the landscape. Physiographic analysis of the province (Figure 2.1) has provided the following landform statistics (P.E.I. Department of Agriculture and Forestry, 1980):

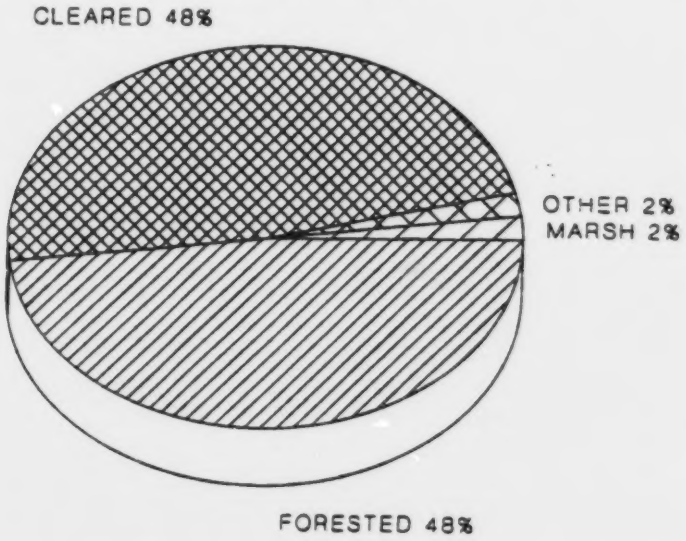


Figure 2.1 Physiographic Analysis of Prince Edward Island

The combination of gentle slopes and fine, sandy loam soils makes the Island ideal for farming and with slightly more than half of its land surface cleared, P.E.I. has a larger portion of its territory devoted to agriculture than any other Canadian province. Livestock production and potato and tobacco cultivation comprise the major farming operations.

Forty-eight percent (48%) of the Island's landbase is forested with 274,234 hectares (ha) covered by trees. P.E.I. falls within the Acadia Forest Region (Rowe, 1959). The central section of the province supports mixed forests of tolerant hardwoods and conifers. White and black spruce, balsam fir and red maple are characteristic species found in the western third of the Island and on the east and north coasts.

2.3 Climate

Close proximity to the Gulf of St. Lawrence allows Prince Edward Island to enjoy a humid temperate climate. Winters are long and fairly cold and summers are cool. The mean annual temperature is six degrees Celsius. The growing season, that is, the number of days between the last spring frost (0 Celsius

or lower) and the first fall frost varies considerably by location and ranges from 100 to 160 days. The degree days above 5 Celsius (May to October) have been observed to vary between 1677 and 1712 degree-days (Treidl, 1978). Annual precipitation is about 1016 millimetres (mm), of which 254 mm to 406 mm falls as rain during the growing season. Figure 2.2 illustrates mean annual precipitation during the period 1951-1980 (Inland Waters Directorate, 1989).

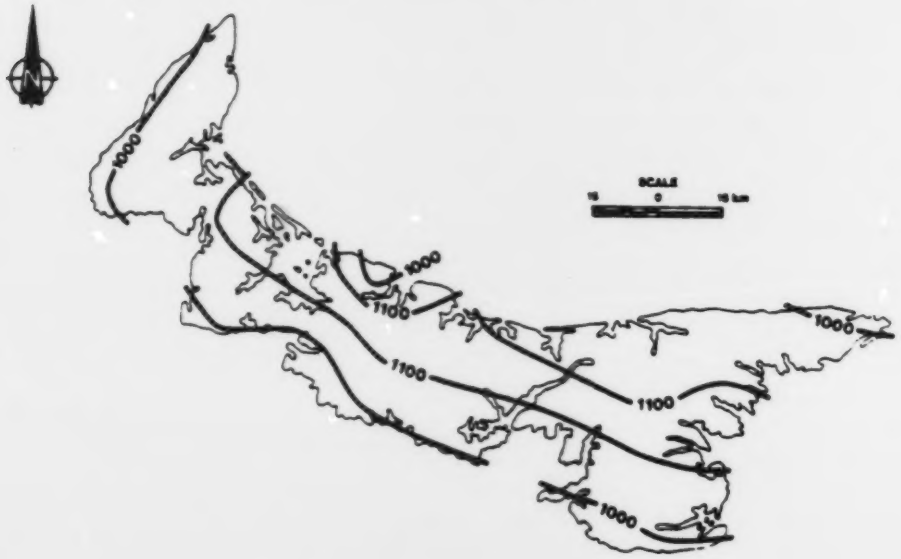


Figure 2.2 Mean Annual Precipitation (1951-1980)

2.4 Soils

The Island's podzol soils, formed from both the weathering of sandstone bedrock and the deposition of glacial till, are generally stone-free, sandy and permeable. More recent deposits of sand, muck and peat prevail in scattered locations.

Sandy loam soils have good drainage, but the clay loams restrict moisture movement and are imperfectly to poorly drained. All soils on P.E.I. are characterized by a low natural fertility. The Island mineral soils have been grouped into seven capability classes and nine subclasses on the basis of soil survey information by the Canada Land Inventory for Agriculture and are described as follows: Class 1; deep, well to imperfectly drained, hold moisture well, well supplied with plant nutrients, managed and cropped without difficulty, moderately high to high in productivity for a wide range of crops; Class 2; deep, hold moisture well, moderate limitations, moderately high to high in productivity for a wide range of crops; Class 3; limitations affecting one or more of the following practices: timing and ease of tillage; planting and

harvesting; choice of crops; and methods of conservation. Fair to moderately high in productivity for a fair range of crops; Class 4; limitations seriously affecting one or more of the following practices: timing and ease of tillage; planting and harvesting; choice of crops; and methods of conservation. Low to fair productivity for a fair range of crops but may have a high productivity for specially - adapted crops; Class 5; severe limitations which inhibit sustained production of annual field crops. Can produce native or tame species of perennial forage plants and may be improved by the use of machines. Improvements may include bush clearing, cultivation, seeding, fertilizer or water control; Class 6; provide some sustained grazing for farm animals but severe limitations inhibit feasible improvement by machinery; Class 7; have no capability for arable culture or pasture. Includes rocklands and bodies of water too small to show on maps; and Class 0; organic soils which are not placed in capability classes.

Each of the above classes of soils can be divided into separate subclasses described as follows: Sublass C; main limitation is low temperature, low to poor distribution of rainfall during the cropping season or a combination of both of these factors; Subclass E; past damage from erosion limits the use of the land for agricultural purposes; Subclass I; lands which are flooded by streams or lakes; Subclass P; stones interfere with tillage, planting and harvesting; Subclass R; solid bedrock is less than 0.92 metres from the surface; Subclass S; soil limitations which include one or more of the following: undesirable structure, low permeability, restricted rooting zone, low natural fertility, low moisture-holding capacity and salinity; Subclass T; either steepness or pattern of slopes limits agricultural use; Subclass W; excess water other than from flooding. May be due to poor drainage, high water table, seepage or runoff from other areas; Subclass X; soils which have moderate limitations caused by the cumulative effects of two or more of the above-mentioned adverse characteristics which singly are not serious enough to affect the class rating.

Throughout much of the province, Class 2 and 3 soils predominate (Canada Land Inventory, 1968).

2.5 Surface Waters Within Prince Edward Island

Surface water may be defined as any water whose surface is in contact with the atmosphere. It includes water contained in ponds, lakes, streams and rivers. The Surface Water Program, Watershed Inventory Project is concerned with fresh water systems and portions of their estuaries. A critical factor in the study of surface water is the concept of a drainage basin or watershed. Basically, a watershed encompasses all that land which is drained by a given water system and, is therefore,

delineated by the highest points of land surrounding that system. Within a watershed, surface water runoff drains by gravity into the tributaries, then to the main river, and finally into the estuary. Thus, the quality of water within the upper reaches of a system ultimately affects the quality of water in its lower reaches.

The twelve watersheds being examined by the Watershed Inventory Project under the Canada-Prince Edward Island Water Management Agreement drain a land area of 3073.4 square kilometres through 2568.7 kilometres of rivers and streams. Their estuaries comprise a total area of 195.6 square kilometres (Taylor, 1988).

Surface water quality in Prince Edward Island streams varies from one waterway to the next. There is no one typical sample or list of general characteristics for Island rivers. Environment Canada maintains numerous water quality/quantity monitoring stations on P.E.I. Cumulative water quality data from these stations can be obtained through the publication Historical Streamflow Summary · Atlantic Provinces · To 1988.

Rain and melted snow, which may be acidic as it falls, percolates through the soil and is buffered to a pH of between 7 and 7.5 as it passes over the limestone bedrock. This water then rises to the surface as spring water feeding brooks and streams. Almost all of the surface water on Prince Edward Island originates from groundwater while the remainder comes from precipitation or runoff.

The Micmacs and early European settlers first used Island waterways as routes for the easy movement of people and goods. They also harvested fish and shellfish from the rivers and streams and trapped animals around them for export. Water wheels were established on many rivers for use as an industrial power source in order to saw trees into lumber, grind wheat into flour, and, in later years, to generate electricity.

Since the 1880's, the importance of mills decreased with the development of electrical power and many of the dams fell into a state of disrepair (McAskill, n.d.). Today, most dams on P.E.I. are designed to provide enhanced habitat for fish, aquatic mammals and waterfowl, as well as creating impoundments for finfish aquaculture operations.

Historically, problems affecting the quality and quantity of most P.E.I. streams and rivers include (Thompson, 1988):

- widening and shallowing;
- a constant heavy silt burden and sedimentation in streams and estuaries;
- the infilling of ponds;

- the widespread accumulation of natural debris;
- the loss of gravel spawning redds and of stream deeps;
- unstable stream banks;
- the loss of stream shading;
- the obstruction of fish passage;
- the elevation of summer season water temperatures; and
- the excessive production of aquatic plants.

As well, sawdust accumulation has been a historical problem for P.E.I. streams and rivers (Godfrey, 1989).

In recent years these problems have been further compounded by new and more intensive agricultural practices and the extensive upgrading and paving of roads within the province.

Problems currently associated with surface water in P.E.I. include siltation from improper road construction and maintenance techniques and poor farming methods. Bacterial contamination of the streams and rivers results from the dumping of untreated and partially treated sewage and manure. As well, industrial contamination results from the direct dumping of wastes and the accidental and incidental flow of materials such as salt, oils and various chemicals into Island waterways.

The future uses of surface water on Prince Edward Island will depend on decisions that are made today. Clean water is a necessity for the expansion of the aquaculture and marine harvesting industries. It is also a major ingredient for a healthy wildlife population on P.E.I. The quality of rivers and streams in future years will also assist in determining the future success of such tourism-related activities as swimming, boating and sport fishing. The Watershed Inventory Project will become an integral part of the future decisions made regarding the quality and quantity of the resource.

3.0 AGRICULTURAL OPERATIONS

Agriculture plays an important role in the economy of Prince Edward Island. There are many livestock and cropping operations located throughout the province. Surface water usually plays an important part in many of these operations. It is used as drinking water for cattle and for crop irrigation and spraying purposes.

Many of the Island's rivers and streams flow through agricultural lands. It is essential that adequate protection of these waters is ensured in order that they remain free from contamination arising from agricultural practices. This can be accomplished through education, the enforcement of existing legislation and, where necessary, the drafting and introduction

of new legislation. This will allow the surface water requirements of other users such as the industrial, aquacultural and recreational sectors and fish and wildlife species to be unaffected.

3.1 Dairy (Beef) Operations

The effects on surface water due to dairy and beef operations are quite pronounced. If grazing cattle are unrestricted in their access to streams and rivers coursing through pastures, water quality will be deleteriously affected. Destabilized stream banks result in the destruction of undercut hiding areas for fish. Sedimentation and siltation destroy gravelled spawning areas. Cattle also contribute to the bacterial and nutrient loading of water. In turn, this will increase plant life thereby reducing the dissolved oxygen levels, clogging the stream and slowing water flow.

Protective measures include limiting stream access by cattle through fencing and the maintenance or planting of greenbelts along stream corridors in order to slow or prevent entry of silt or contaminants.

Beef feedlot operations on P.E.I. are situated on hard-packed earthern lots but concrete bases are becoming more and more prevalent (Murphy, S., 1988). These small enclosed areas, containing a large number of cattle, also have a negative effect on surface water quality. These negative effects occur primarily as a result of manure runoff, especially during the spring thaw or heavy rains. Protection measures include locating the feedlots away from streams and on level ground. An adequate manure storage and disposal system should also be implemented.

3.2 Hog Operations

Hogs are normally housed indoors with the only threat to the quality of P.E.I.'s surface water resources resulting from manure storage and disposal (Jenkins, 1988). However, during Watershed Inventory Project fieldwork, hogs from small operations have been observed in pastures. This can result in erosion and water contamination problems due to manure runoff and stream access by the animals.

3.3 Poultry Operations

Poultry operations are usually self-contained with surface water problems arising due to manure storage and disposal. Most larger operations house the poultry indoors. Improper disposal of dead poultry can lead to disease and contamination of water, wildlife, domestic animals and humans.

3.4 Stock Watering

Most P.E.I. livestock, including those contained in feedlots, drink groundwater which is piped into troughs (Murphy, S., 1988). However, during fieldwork, cattle and hogs were observed drinking from the streams and rivers traversing pastures. This activity results in bank erosion and sedimentation and leads to deterioration of fish habitat. Surface water is also affected by increases in bacterial levels and nutrient loading due to wastes voided by livestock while in or near streams.

3.5 Crop Spraying

Spraying operations, using herbicides, pesticides or fungicides, are partially monitored by the P.E.I. Department of Agriculture. The chemicals regularly used are listed in Appendix A. Surface water is most often mixed with these chemicals with the amount largely dependent upon the type of crop and the size of the operation.

Cereal crops are usually sprayed only once per year. Potatoes are normally given one herbicide application in the spring (they may also receive an additional application if there is a grass problem), one or two insecticide applications over the course of the growing season, and a fungicide spray every 7 to 10 days. Growers may also spray for aphids late in the season. Top killers are generally applied to potatoes prior to harvesting (Craig, 1988).

Since spraying operations involve the use of toxic chemicals their potential effects on surface waters and fish and wildlife could be devastating. There are, however, regulations enacted which prohibit spraying near waterways [P.E.I. Pesticides Control Act, Section 16(2)(c)]. As well, sprayers cannot be directly filled at a surface water source. The water must be transferred from a separate water tank into the sprayer [P.E.I. Pesticides Control Act, Section 17].

3.6 Irrigation

The P.E.I. Department of Agriculture does not keep specific records regarding crop irrigation by farmers within the province. However, it is known that the water used for such purposes generally comes from nearby surface sources such as a farm pond or stream. In unusually dry years, such as 1987, there are more farmers on average who have to irrigate their crops (Clough, 1988).

Irrigation, especially during the dry season, results in decreased water levels. The low water availability can have an effect on other users of the resource and, therefore, should be

monitored in order to guard against this occurrence.

3.7 Tile Drainage Projects

Tile drainage enables farmers to increase the productivity of low class agricultural lands (DeHaan, 1989). Specifically, it extends the growing season, reduces winter kill, improves soil structure, reduces soil compaction, allows for better utilization of fertilizers, optimizes yields, improves access by machinery and reduces runoff. This is accomplished by burying lengths of perforated plastic pipe thereby allowing seepage of moisture from the surrounding soil. Most often, the outlet, which is usually marked by a steel stake, drains into a ditch near wooded areas. The effluents from particular projects are not usually monitored but samples are occasionally taken.

There is, however, an automated sampling station located on the Agriculture Canada Research Station Farm in Harrington, P.E.I. in which nitrate effluents from tile drainage projects are tested. Basically, the objective of this testing is to obtain information regarding the operation of a field system in order to detect nitrate effluent in drainage water under a range of cropping systems. Preliminary research has shown that not all of the nitrate is retained by the soil but that some is leached into the soil profile and can be detected in the drainage effluent (McLeod, 1988). These results indicate that nitrite levels in virtually all samples are less than safe levels for drinking water.

The effects of tile drainage projects on surface water are varied. The effluent, if allowed to flow into a stream, river or pond, results in increased sedimentation, nutrient enrichment and, in some cases, higher bacterial and chemical counts. However, draining subsurface water from agricultural lands reduces surface runoff and traps non-water soluble materials (phosphorus, micro-nutrients and some pesticides) in the soil.

3.8 Erosion Control Projects

Since soil erosion is a major concern in Prince Edward Island steps must be taken to combat not only the fact that we are losing our most productive soils but also to address the degradation of our streams resulting in the loss of fish habitat. Some methods used to control the pace of the continuing loss of soil include; contour farming, strip cropping, grassed waterways and outlets, diversions, terracing, cover crops, chisel plowing and the establishment of hedgerows and greenbelts.

Contour farming, that is, plowing and planting across the

slope creates numerous small dams which prevent the water from flowing rapidly through the field and carrying away the soil. It should, however, be used in combination with various other erosion control methods.

Strip cropping is the practice of alternating contour strips of sod, small grain and row crops. The strip width is dependent upon the degree and length of slope, soil infiltration capacity, water holding capacity of the soil and rainfall, among other factors.

Grassed waterways and outlets are excavated channels designed to carry and dispose of runoff water at non-erosive velocities. These are most often used to drain water from surface depressions or diversion terraces.

Diversion ditches are vegetated channels with a V-shaped or flat bottom which intercept runoff before it gains enough speed and volume to cause erosion. Runoff is then diverted into a safe outlet or grassed waterway.

Terraces are channel-ridge combinations built along the side of a slope or on the contour to intercept flowing water. They are designed to contain water until it seeps into the soil.

Cover crops are a good method of erosion control for two reasons. Primarily, they protect the soil against runoff when the fields do not have their regular crop cover on them. Also, when plowed under prior to planting the regular crops, they increase the organic matter content of the soil and therefore, its infiltration capacity.

Mulching, that is, the cutting of hay or straw and subsequent spreading or discing with bare soil, is an effective method of reducing soil erosion. Evidence has shown that both the runoff velocity and total sediment loss are reduced (Edwards, 1988).

Chisel plows can best be used in a crop rotation when the land is bare or in stubble. This minimum till or no-till system can be used with row crops and is based on the principle of leaving more stubble on the soil surface. Reduced disturbance will improve the water infiltration rate thereby lessening soil erosion.

Hedgerows reduce the velocity of the wind and thus the loss of soil due to wind erosion. During the winter months they also act as snow fences which allow for increased snow cover and, therefore, the protection of plowed fields.

Greenbelt establishment, or the planting of trees and shrubs along the edges of surface waterways for a distance of

three chains (approximately 55 metres) is important in protecting existing fish habitat and water quality (Guignon, 1988). Other provinces require greenbelts as narrow as five metres and the P.E.I. Forest Resource Development Agreement defines a greenbelt as being at least ten metres in width. Aside from being aesthetically pleasing, greenbelts are able to slow runoff from cultivated fields or steep slopes, thereby allowing it to be absorbed into the ground instead of entering the watercourse.

3.9 Cull (Waste) Potato Disposal

The P.E.I. Department of Agriculture and the Water Resources Branch of the P.E.I. Department of the Environment recently delineated various guidelines concerning the disposal of cull (waste) potatoes (Appendix B). All producers wishing to dispose of cull potatoes must first obtain site approval from the P.E.I. Department of Agriculture if they are to be considered for financial assistance. Beginning with the 1988 growing season, all approved burial sites will be mapped by the P.E.I. Department of Agriculture (McQuarrie, 1988).

Problems occurring to surface water quality as a result of improper cull potato disposal include nutrient enrichment and bacterial loading.

3.10 Dead Stock Burial

The only guideline protecting surface water resources in relation to dead stock burial is that the carcasses are not accepted at municipal landfill or container sites. However, as these sites are unattended, materials entering the site are not monitored on a continuous basis.

Some farmers pay an annual membership fee to have their dead stock removed by Maritime Pet Foods which is located in Stanchel (Younie, 1988). Many bury their dead animals on their own land. It has also been noted that some dead stock have been dumped directly into streams. This practice, aside from destroying the aesthetic quality of the area, leads to contamination of the waterways and disease to wildlife, other domestic animals and humans.

3.11 Manure Storage and Disposal

In Prince Edward Island there are specific guidelines set for the storage and disposal of manure depending upon its moisture content (P.E.I. Department of Agriculture, 1986). Basically, all manure storage facilities must have a capacity for at least two hundred (200) days' accumulation. Manure must be spread on fields with the intention that it will be mixed in with the soil with losses due to runoff kept to a minimum. As

a general rule manure should be spread in the spring or fall. It is also not recommended to spread manure in July and August unless it is immediately mixed in with the soil.

Runoff of manure into surface water results in nutrient enrichment and bacterial loading. This, in turn, causes increased plant growth and reduces water flow thereby decreasing the amount of oxygen in the water.

3.12 Land Clearing and Plowing

With more than half of its land base cleared (Real Property Records Division, 1989) Prince Edward Island has a higher percentage of its land devoted to agriculture than any other province in Canada. Most of P.E.I.'s good agricultural land has been under cultivation for some time. However, much of these lands are being lost to development. Other areas have been cleared of trees to increase pasture and crop acreages. This is not usually a problem except if the lands being cleared are situated on slopes or if the vegetation is removed directly to the edge of the waterway. This practice destroys the silt trapping capabilities of tne land and, in turn, increases the landwash problems to the rivers and streams.

Improper plowing also has a detrimental effect on surface water by increasing both the soil erosion and landwash rates. For example, plowing directly up and down a slope allows runoff water to gain velocity and carry away soil and fertilizers or pesticides contained in the soil. This leads to siltation of the stream bottom, nutrient enrichment and bacterial and chemical contamination of the waterways.

3.13 Soil Erosion

Prince Edward Island's economy relies on three major industries: agriculture, fisheries and tourism. All are somewhat related since good agricultural practices preserve fish, wildlife and inshore fish and shellfish habitat by protecting water quality. Aesthetic surroundings lead visitors to the province.

If not controlled, soil erosion will degrade fish habitat and reduce the amount of productive cultivated lands. Soil management has two purposes; to grow crops for profit and to preserve and improve soil quality over the long term.

Soil erosion on P.E.I. is aggravated by four circumstances (Veer, 1989):

1. frozen soil layers at shallow depth on winter-bare land; frost, snow, rain and numerous freezing-thawing cycles. Most winter-bare land is caused by a late

season crop in a difficult to change farm management system;
2. a topography with relatively long and often convex slopes;
3. natural soil-physical attributes such as; relatively low water storage capability and a high silt and very fine sand content, often very low levels of organic matter which results in easily destroyed (low strength) soil structure in most plow layers; and
4. the fact that most fields have the longest distance in the direction of the slope.

Figures reveal that on average an Island agricultural field in a standard grain and potatoes rotation can easily lose several tonnes of soil per hectare each year due to water-borne losses. Wind erosion increases this soil loss amount even more (Marenco Engineering Limited, 1987). Additional statistics reveal five year soil losses of 0.2 tonnes per hectare on a sod field whereas an agricultural field with potatoes growing up and down the slope loses 19.6 tonnes per hectare. The latter value can be reduced by one-third if the potatoes are grown across the slope (Standing Senate Committee on Agriculture, Fisheries and Forestry, 1984).

This continued loss of soil results in lost time for the farmer, lower productivity rates of the field, decreased soil stability and resistance leading to further erosion and ultimately to clogged waterways. Farmers must then use more fertilizers in order to attain comparable productivity from the subsoil layers. More fertilizers added to already unstable fields result in a higher rate of nutrient loading to streams and rivers arising from runoff.

4.0 FISH AND WILDLIFE RESOURCES

Fish and wildlife species, aside from forming part of Prince Edward Island's heritage, comprise a major recreational resource. Even though modern day P.E.I. is oriented towards outdoor recreational activities that depend partly on wildlife, the economic value tends to be overlooked. In 1981 P.E.I. residents spent approximately $8.2 milion on wildlife-related activities. Of that total, thirty-five percent (35%) was spent on consumptive activities while sixty-five percent (65%) was spent on non-consumptive wildlife pursuits and contributions to wildlife-related organizations (Canadian Wildlife Service, 1986).

Fish and wildlife on P.E.I. are dependent upon clean surface water resources for either primary habitat or a drinking source. Therefore, it is essential that the surface waters within the province remain relatively free from

contamination and siltation in order for wildlife to continue to thrive. Familiar types of wildlife found on the Island along with their basic habitat requirements are identified in Table 4.1.

In addition to the bird species mentioned in Table 4.1, P.E.I. is also a home and important feeding and resting area for many species of waterfowl including Canada geese, snow geese, black ducks, mallards, pintails and blue-winged teal and songbirds.

Fish species found in Island waters include brook (speckled) trout, rainbow trout, Atlantic salmon, white perch, striped bass, gaspereau, banded killifish, common killifish (mummichogs) and sticklebacks (Scott and Crossman, 1975).

4.1 Angling Areas

Recreational fishing (angling) on Prince Edward Island is very popular. The number of angling licenses distributed on the Island each year averages about 14,000 (Figure 4.1). The areas most frequented on P.E.I. by recreational fishermen are listed in the P.E.I. Department of Tourism publication Angling on Prince Edward Island. There are several additional angling areas which have been delineated by Fish and Wildlife Branch's conservation officers in each of the study watersheds.

Potential degradation to the quality of surface water exists in all angling locations although the higher use areas would be most susceptible.

4.2 Hunting Areas

In 1987, there were about 5000 hunting licenses distributed on Prince Edward Island (Figure 4.1). Game on P.E.I. includes several species of waterfowl, snowshoe hare, ruffed grouse, Hungarian partridge, pheasant, woodcock and snipe.

The conservation officers from the P.E.I. Fish and Wildlife Branch delineated the most frequented hunting areas in the study watersheds. In keeping with the migratory habits of wildlife, in response to food availability and other habitat requirements, these areas do not have rigid boundaries and are therefore not static from year-to-year.

P.E.I. is an important stopover area on the Atlantic Flyway for migrating waterfowl (Figure 4.2), (Curley and MacKinnon, 1988). Various demands, therefore, can be placed on the Island's surface waters by the many people who hunt waterfowl in the province every year. Sedimentation, nutrient enrichment and chemical and bacterial contamination originating from the upper areas of the streams and rivers which drain into the

Table 4.1 Habitat Requirements for Birds and Furbearing Animals on P.E.I.

Birds*

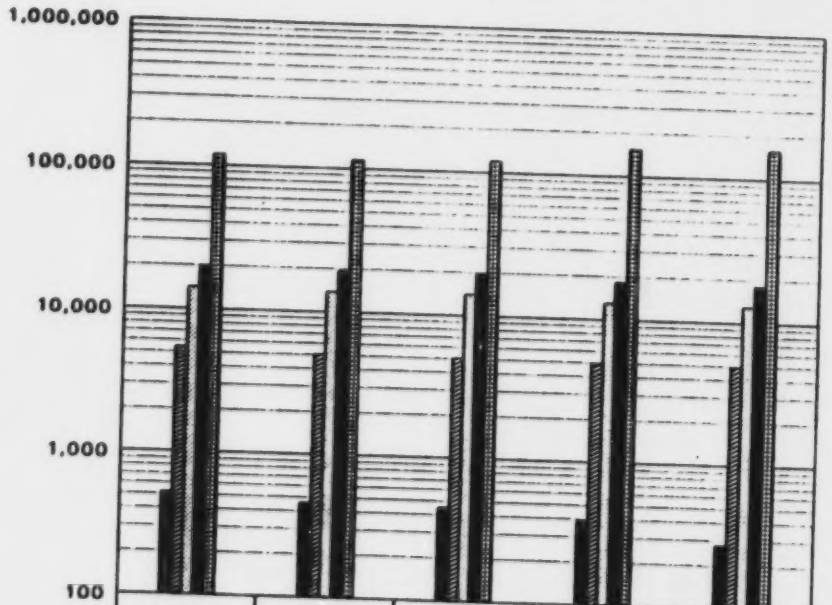
Species	Habitat Description
Bald Eagle	Usually in vicinity of water and in adjacent countryside.
Goshawk	Forests and woodlands (preferably mixed); forest edges and clearings.
Kestrel	Hunts in open country, fields, meadows and burn areas.
Marsh Hawk	Open fields, marshes (fresh and salt) and meadows.
Merlin	Hunting habitat includes marshes, beaches, mudflats and fields.
Osprey	Vicinity of lakes, rivers and coastal bays.
Peregrine Falcon	Vicinity of cliffs and adjacent habitat during breeding, shores and marshes at other times.
Red-tailed Hawk	Woodlands and open country, cliff ledges used for nesting when trees not available.
Rough-legged Hawk	Only in P.E.I. during migration periods — requires open country such as fields and marshes.
Sharp-skinned Hawk	Woodland and woods' edges; also found on shores frequented by other bird migrants.
Barred Owl	Dense forests especially near lakes, streams, swamps or marshes.
Great Horned Owl	Deciduous and coniferous woods varying from extensive heavy woods to isolated groves.
Saw-whet Owl	Boggy coniferous and deciduous woodlands; also dense alder thickets and cedar and tamarack bogs.
Short-eared Owl	Open grasslands, grassy or bushy meadows, freshwater and salt-water marshes and bogs.
Snowy Owl	Migration times in P.E.I. — fields, marshes, coasts, lakes and river shores.
Common Snipe	***Breeding season*** — various types of large and small freshwater marshes, bogs, marshy edges and moist meadows. ***Migration periods*** — ploughed or "puddly" fields, wet stubbles, ditches and creeks; also upper salt marshes.
Gray (Hungarian) Partridge	Open grasslands and agricultural fields.
Ring-necked Pheasant	Farmland with fields of grain, corn, alfalfa, soybeans, grass and weeds near cover, marsh edges and ungrazed woodland edges.
Ruffed Grouse	Mainly second growth deciduous and mixed woodlands, woods' edges and openings, alder and willow-edged streams.
Woodcock	***Spring*** — male singing grounds are in various-sized clearings in or near areas of low immature open mixed wood or hardwood or alder-willow thickets. ***Autumn*** — areas of moist alder thickets and also dry second growth areas are frequented.

Furbearing Animals**

Species	Key Components of Habitat
Red Squirrel	Dense or clumped stands of mature and coniferous to deciduous woods, multi-storied stands; also need sufficient moisture/shade for cone storage.
Beaver	Need suitable foods within suitable foraging distances (less than 100 metres) from water.
Muskrat	Permanent water of sufficient depth or velocity to prevent total freeze; need herbaceous aquatic vegetation and herbaceous vegetation in riparian zones.
Coyote	Cleared forested lands and agriculturally-developed lands.
Red Fox	Edge cover areas between cleared lands and forested lands.
Long-tailed Weasel	Shelterbelts and fencerows; fruit-producing shrubs and trees.
Striped Skunk	Forest/shrublands and agricultural lands.
Mink	Permanent surface water; vegetative cover within and adjacent to wetlands, logjams, boulders, etc., needed to provide cover for foraging and den sites.
Raccoon	Wetlands, riparian habitats, buildings and woodpiles for denning.

*Adapted from Godfrey, 1966.
**Adapted from Novak et. al., 1987.

PRINCE EDWARD ISLAND
ANGLING, HUNTING AND TRAPPING LICENSES



	1984	1985	1986	1987	1988
TRAPPING	520	460	450	390	279
HUNTING	5,401	5,052	5,050	4,908	4,914
ANGLING	14,191	13,878	14,087	13,045	12,973
TOTAL LICENSES	20,112	19,359	19,587	18,343	18,166
REVENUES ($)	118,646	114,438	119,388	153,465	157,776

YEAR

LEGEND
- TRAPPING
- HUNTING
- ANGLING
- TOTAL LICENSES
- REVENUES ($)

Figure 4.1 Prince Edward Island Angling, Hunting and Trapping Licenses

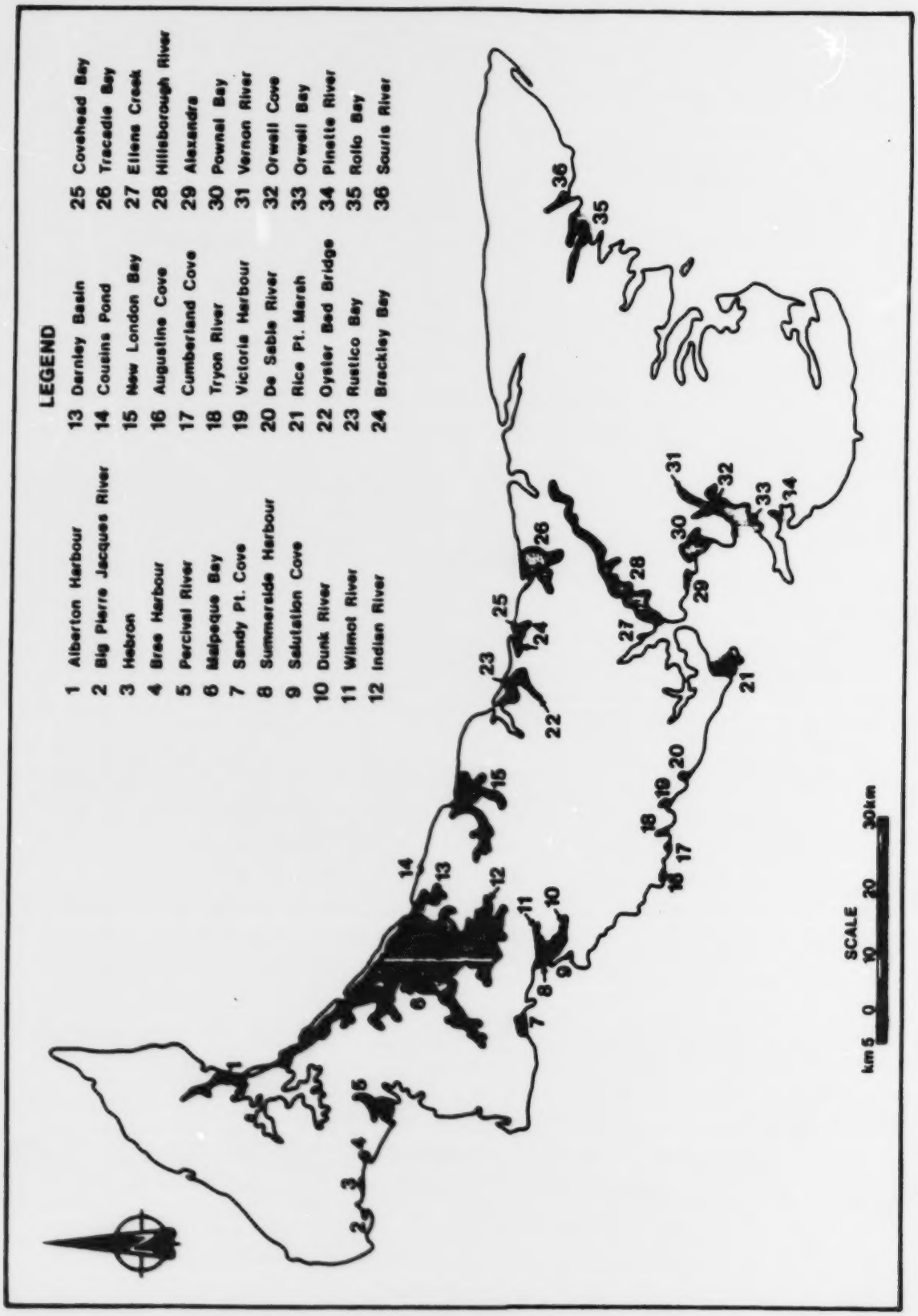


Figure 4.2 Major Waterfowl Migration Habitats

estuaries can affect their suitability as stopover points for migrating waterfowl.

4.3 Trapping Areas

Trapping is fairly lucrative on Prince Edward Island with the sales of wild beaver, muskrat, fox and mink furs amounting to over $100,000 during the 1986-87 trapping season (P.E.I. Fish and Wildlife Branch, 1988). There were about four hundred (400) trapping licenses distributed within the province during the 1987-88 season (Figure 4.1).

As with hunted species the territorial boundaries of trapped species are dependent upon food availability and other habitat requirements and may vary from year-to-year. Trapped furbearers on P.E.I. are dependent upon surface water either for primary habitat or as a drinking source.

Negative effects of trapping activities on surface water include sedimentation, nutrient enrichment and bacterial contamination. Measures which can be implemented to guard against these problems include user education and water edge planting and stabilization of access points.

4.4 Beaver Activity Areas

Beaver-built dams result in various-sized flooded areas called flowages. Often, the dams are responsible for the blockage of fish passage into upstream spawning areas and destruction of trees and other vegetation on upland areas which have been flooded. On a positive note, however, flowages are also responsible for newly-created waterfowl and aquatic mammal habitat.

There are many beaver flowages located throughout the province which have been delineated for the Watershed Inventory Project by the conservation officers and biologists. The effects of beaver dams and flowages on fish and wildlife may be positive or negative, however, their effects on the quality of surface water resources are minimal.

5.0 FORESTRY OPERATIONS

Forests protect watersheds. Therefore, in a province where approximately half of the land base is covered by trees, forests and forestry operations may be expected to have a marked impact on surface water quality and quantity. The small size of woodlots on P.E.I. combined with the variations in stand types on most woodlots has minimized the impact of forestry cutting operations on surface water quality and quantity. The diverse nature of cutting operations in

combination with fertile soils and rapid revegetation minimizes erosion on most of the forested lands within the province. In addition, the bulk of the clearcutting operations are restricted to lands with minmal slopes due to both their restricted access by machinery and the limited amount of high sloped lands within the province.

Principally, woodlands influence water volume by functioning as large catchment basins collecting rain and snowmelt and gradually releasing it to streams and rivers. Peak flows and flooding are reduced but flow is sustained during dry periods. This regulated release is of particular importance to fish, waterfowl and other aquatic life forms that depend on a continuous flow or near-constant water level to provide suitable habitat requirements. Similarly, it is beneficial to those sectors of the agriculture or recreation based populace that otherwise utilize surface water resources.

In addition to regulating volume streambank vegetation also serves to influence water quality, particularly in terms of its suitability for fish habitat. Trees and branches that fall naturally into a stream help to create the diversity of pool and riffle areas upon which stream productivity depends. Tree, shrub and plant roots, together with forest litter, bind and stabilize soil particles thereby filtering and slowing landwash. Clear, silt-free water and clean gravel beds are necessary for many aquatic organisms. Downstream, estuarine shellfish resources are strongly influenced by the siltation level of inflowing water. Similarly, aesthetic appeal and recreational potential are enhanced by good water quality.

Overhanging and submerged plants can further enhance fish habitat by providing protected resting and feeding areas and by playing a role controlling water temperature. Water temperatures in P.E.I. are mainly controlled by high groundwater input to the base flow of her streams and rivers. The plants also provide habitat for insects which are an important source of food for fish. Organic material falling into the streams and rivers also provides food and additional habitat for the aquatic insects.

Because of the influence of woodland on the surface water traversing it, forestry operations conducted within a watershed may have both beneficial and detrimental impacts. Often, however, it is not so much the scope (size) of the activity but the actual forestry practice which is undertaken, that is, the manner in which it is applied and the location and timing of operations. The situation becomes even more complex when one realizes that the locations and scope of forestry operations necessarily change from year to year within any given watershed.

For example, clearcutting (the removal of all harvestable biomass from a woodlot), while often viewed from a negative perspective, may indeed be beneficial to a watershed over the long run when conducted properly. Removal of dense, overmature softwood, a common forest type on Prince Edward Island, allows for greater light penetration and thus increased plant growth. In turn, this will provide better soil stability, less landwash and improved surface water quality and aquatic habitat as the new forest grows.

Vegetative impacts arise when cut-over areas are excessively large, when they do not regenerate naturally or are not replanted, when steep slopes are disturbed, or when vegetation is removed from the edge of a stream, river, or pond. Under these conditions surface waters are often exposed to increased landwash. In-stream pools and spawning beds become silted and non-productive, ponds and other wetlands infill and become shallow and warm, channels widen and flow is reduced. Bottom-dwelling plants and animals, vital components of the aquatic food web, may be reduced in numbers, buried in silt or washed away. In extreme cases, sections of streams or rivers become completely blocked to fish passage.

These negative impacts have far reaching consequences to numerous other surface water users as well. Reduced stream flow and high siltation levels can result in costly machinery maintenance and insufficient water for agricultural use for crop irrigation or spraying. Productive estuarine systems become choked. Recreational use of the aquatic environment may also decline as fishing, hunting, and trapping potentials fall and aesthetic appeal disappears.

If the cleared area is to return to trees, silvicultural activities such as site preparation, planting, brush removal, and thinning can be carried out to establish and nurture the new forest. Burning and mechanical cultivation are often used to prepare sites for planting, however, if proper care is not exercised, these activities will also increase sedimentation in streams. Chemical biocides or pesticides used to control brush and insects pose serious problems to fish if runoff to surface water occurs.

Selective cutting, thinning and other clearing operations designed to improve the productivity of a woodlot need not pose a problem to surface waters. However, failure to ensure adequate greenbelts along riparian zones or undue disturbance on slopes lead to increased siltation, higher water temperatures and decreased fish habitat and populations.

The construction of woodlot access roads and associated stream crossings may hold the greatest potential for affecting the quality and/or quantity of surface water resources. The

building of roadways too close to streambanks or along steep ridges, failure to maintain adequate greenbelts and improperly constructed, or oftentimes non-existent, stream crossing structures lead to increased landwash and, therefore, problems commonly associated with excessive siltation. The Canada - Prince Edward Island Forest Resource Development Agreement (F.R.D.A.) Schedule of Rates and Standards contain stringent criteria for the installation of stream crossings on woodlot roads (Canada - Prince Edward Island Forest Resource Development Agreement, 1988).

Thus, while many forestry practices do have associated with them an inherent potential to alter or damage the quantity, quality and productivity of surface waters, that is not to infer that the absence of forest management activity will necessarily result in a better aquatic environment. Landwash and siltation may indeed pose less of a problem, but blowdown and deadfall, particularly within sections of overmature woodland, may result in blockages or barriers to fish passage. As well, untended streams or rivers may become choked by excessive shrub or plant growth. The aesthetic appeal and recreational potential of areas such as these are also greatly reduced. Careful planning and a better knowledge of multiple resource management can, however, do much to avoid or significantly reduce many of the potentially detrimental effects of forestry operations.

Across Prince Edward Island, implementation of the F.R.D.A. has done much to rejuvenate the forest industry and escalate forest improvement operations within the province. Under the Agreement, focus is to shift from the removal of pulpwood to management of P.E.I. woodlots for sawlog production. Since 1982, the following forestry activities have been subsidized under the F.R.D.A. (Canadian Forestry Service, 1988):

- Site reclamation	1211	hectares (ha)
- New plantation	3082	ha
- Stand improvement	2526	ha
- Salvage cutting	40	ha
- Boundary line establishment	666	kilometres (km)
- Access road construction	391	km
- Bridge construction	241	square metres

Additional harvesting, clearing, road construction and stream crossing activities may go undocumented each year on privately-owned woodlots. However, with the exception of extreme cases, negative impacts on surface water quality or quantity are probably minimal. Clearcuts are generally of a small size on P.E.I. and harvested areas regenerate quickly. Thinnings and selective cuts pose little problem if greenbelts are maintained along streams and if steep slopes near waterways are not disturbed. The high erodibility of Island soils does

pose a potential problem when stream crossings are concerned but stringent specifications and provincial regulations exist to help minimize damage to the aquatic environment.

6.0 RECREATIONAL ACTIVITIES

Surface water and some recreational activities go hand-in-hand (swimming and boating). Others (hiking and cross-country skiing) are often enjoyed in close proximity to streams and rivers. Similarly, major recreational facilities (provincial parks, P.E.I. National Park, campgrounds and theme parks) are generally situated on or near surface waterways.

Being a tourism-oriented province means Prince Edward Island has a large number of areas in which people may enjoy outdoor recreational activities. Many of these are located near surface water resources. Since there are a large number of visitors to the province during the summer tourist season the cumulative effects of these users can be detrimental to the quality of P.E.I.'s rivers and streams.

6.1 National Parks / Provincial Parks / Private Campgrounds

Activities undertaken while at P.E.I. National Park, provincial parks or private campgrounds include hiking, boating, fishing, camping and swimming. Sedimentation, nutrient enrichment and chemical and bacterial contamination can occur to the water as a result of high use of the resource area.

Parks and campgrounds can help guard against the degradation of surface water quality by providing adequate facilities in order to accommodate large numbers of people. There must also be, if available on-site, adequate sewage and dumping station facilities.

6.2 Swimming Activities

Most of the high use swimming areas in Prince Edward Island are coastal and therefore outside of watershed boundaries. There are forty-four (44) such areas listed in the 1988 Visitors Guide (P.E.I. Department of Tourism and Parks, 1988). However, it is assumed that people will swim anywhere including in many of the freshwater lakes, ponds and rivers found throughout the Island.

The only organized swimming events occurring on freshwater areas are conducted by the Canadian Red Cross Society. Day camps are held throughout the province during the summer months.

Potential effects on the quality of surface water resulting from high swimmer-use include siltation, bacterial contamination and nutrient enrichment.

6.3 Boating / Canoeing Areas

There are numerous sites throughout P.E.I. which are suitable for boating and/or canoeing. The level of recreational activity associated with each of these sites is often determined by personal preference and the location of suitable access points.

The Prince Edward Island Recreational Canoeing Association (PEIRCA) distributes a brochure which lists the locales, conditions of the route and access points (P.E.I. Department of Tourism and Parks, n.d.). The Canadian Red Cross Society also has canoeing activities incorporated into their day programs held during the summer but the routes used are the same as those in the PEIRCA brochure. The annual Red Cross Multi-Sport Relay Race, which in 1988 attracted approximately 170 teams, has a canoeing leg which runs from the Bonshaw Bridge to the bridge at St. Catherines in the West River Sub-watershed.

The Red Cross Society also has an "On the Move" program which is a three-day canoeing/camping trip for its summer staff members. The location usually changes annually with the 1988 route tentatively set for the western area of the province (Barrett, 1988).

There are several marinas located throughout the Island which have the capabilities to handle larger boats. Problems specifically caused as a result of the presence of these vessels include chemical and bacterial contamination and nutrient enrichment. The dumping of boat toilets should be controlled while they are docked or on inland waters.

Boardsailing (windsurfing) is also becoming popular at various locations throughout P.E.I. but the impacts of this activity on water quality are minimal. Motorized boats on inland surface waters cause streambank erosion and stir up bottom sediments thereby degrading fish habitat.

6.4 Hiking / Cross-Country Skiing / Snowshoeing

For the nature buff, a good way to see the Island is on foot, either by hiking, cross-country skiing or snowshoeing. In this way people can go at their own pace, perhaps photographing any subject which catches their eye or just enjoying the great outdoors.

The effects on surface water quality due to these

particular trail activities are dependent upon the amount of use of the trail and their proximity to the waterway. Potential problems include sedimentation, bacterial contamination and nutrient enrichment.

To combat problems, trails near waterways should be stabilized, water access limited and a "Pack-In, Pack-Out" program promoted in which users are encouraged to bring out of the trail system whatever they bring in, including garbage.

6.5 Snowmobiling / All Terrain Vehicles

Snowmobilers often use trail systems or travel over frozen lakes, ponds, and rivers and can be a source of potential problems to surface water quality. There is only one snowmobiling club located on Prince Edward Island. Therefore, most trails receive limited use. Snowmobiling does not appear to be a cause of major problems to the quality of surface water on P.E.I.

In recent years, all terrain vehicles (ATV's) have become an increasing threat to fish and wildlife habitat on P.E.I. due to their ability of travelling in locations usually not accessible by other types of vehicles. Specific problems caused by ATV's include the erosion of stream banks leading to siltation and the loss of essential undercut resting areas used by fish. Access near waterways by ATV operators should, therefore, be restricted in order to avoid the further degradation of surface waterways on the Island.

6.6 Horseback Riding

Horseback (trail) riding is popular on P.E.I. and various operations are located throughout the province. Effects of this activity on the quality of surface water resources is dependent upon the proximity of the riding trails to streams and rivers. These problems include sedimentation, bacterial contamination and nutrient enrichment.

To guard against problems caused by horseback riding guidelines or regulations could be set which would restrict or limit access by horses to streams or rivers along especially vulnerable sections of the trails.

6.7 Unplowed (Seasonal / Scenic Heritage) Roads

Many unpaved and unimproved roads on the Island are not opened for vehicular traffic during the winter months. The relative abundance of such roads across the province provides excellent facilities for winter recreational activities such as cross-country skiing, snowshoeing, and snowmobiling. Often not well travelled even during the warmer season, these roads may

further supply recreational opportunities for hiking, cycling and horseback riding.

Problems related to the quality of surface water and caused by each of these recreational activities have been identified in previous sections.

Some of these roads have been designated as Scenic Heritage Roads. In order to qualify, Prince Edward Island roads must satisfy the following criteria (Horne et. al., 1988):

1. have woodlands bordering the road for at least fifty percent (50%) of its length;
2. have two-way driving, although it may have to be with care in some areas;
3. have a naturally sound or maintained roadbed;
4. be able to see little or no adjacent development from the road;
5. must be publicly-owned; and
6. must have sufficient support from owners of adjacent lands.

7.0 FISHERIES OPERATIONS

All finfish and shellfish harvesting conducted within Prince Edward Island can be placed into three general categories, namely; licensed commercial, non-licensed commercial and recreational and finfish aquaculture. Figure 7.1 indicates the dollar values for each species of fish harvested in the province in 1987 (Aitken, 1988).

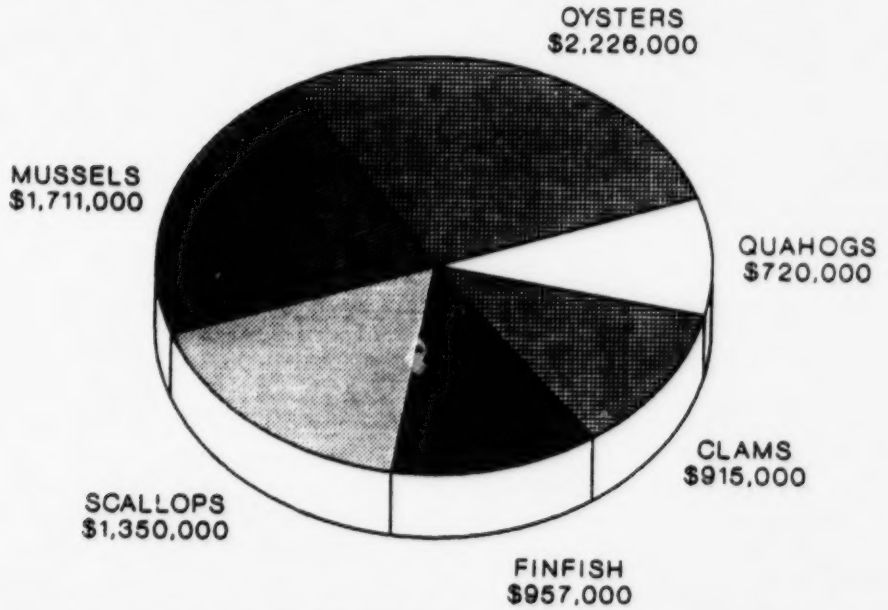


Figure 7.1 1987 Fish/Shellfish Landings. Province of P.E.I.

Threats to the future success of fisheries' operations include sedimentation, unchecked bacterial contamination and chemical pollution of the water. If the public's appetite towards the enjoyment of seafood is threatened, as with the recent (1987) toxic mussel problem (domoic acid), the financial losses could seriously threaten the future of the fisheries industry on the Island.

7.1 Licensed Commercial

All oyster leases and blue mussel line-culture operations require licensing. Proponents wishing to culture blue mussels must first obtain a two-year Conditional Culture Shellfish Permit. If they wish to continue production at the end of that time they are required to apply for an official lease. All aquaculture leases (both shellfish and finfish) remain the responsibility of Fisheries and Oceans Canada (D.F.O.).

While not officially licensed, smelt and gaspereau fishery "berths" are registered with D.F.O. Box nets have all but replaced the more traditional bag nets.

7.2 Non-Licensed Commercial / Recreational

The most recent estuarine inventories, completed during the early 1970's, provide detailed information concerning the occurrence of and relative abundance of all shellfish species on Prince Edward Island.

Accompanying maps identified significant distributions of blue mussels, soft-shelled clams, oysters and quahogs throughout the estuarine systems. Some studies, however, could not be located and are not available for all of the estuaries covered by the Watershed Inventory Project.

The commercial or recreational harvest of shellfish within many estuarial areas on P.E.I. is not permitted due to their closure resulting from the influx of contaminants from upstream sources. However, shellfish can be removed from some of the closed estuaries (Figure 7.2). In order for this to occur, a conditional permit must be obtained by commercial shellfish harvesters. The shellfish which are removed from the 'closure areas' are then taken to noncontaminated areas for flushing (a three to four week period).

7.3 Finfish Aquaculture

During the past several years, finfish aquaculture has gained considerable momentum on Prince Edward Island. There are many new operations starting up on the Island. Some operations house their stock indoors in large tanks while others utilize outdoor rearing ponds. In either case clean

Figure 7.2 Prince Edward Island Shellfish Harvesting Closure Areas

water must be available either through groundwater or surface water sources.

Water used for these operations is often recycled. Most operations do not have the facilities for the retention of wastes which are dumped directly into a nearby surface source. Many either have or are planning to have proper facilities for waste water retention and processing. Not only is the build-up of fish wastes detrimental to the quality of surface water but it can also be the source of various diseases among the finfish stocks within the aquaculture operation.

Since finfish aquaculture is a relatively new industry on P.E.I. there are, at present, very few guidelines in place to restrict its growth and to monitor the businesses. The number of operations on any given river system must be limited to ensure an adequate quantity of water for all users of the resource. Sedimentation to rivers and streams during the construction phase must also be monitored and controlled.

8.0 INDUSTRIAL OPERATIONS

Many industrial activities on Prince Edward Island are closely associated with surface water resources. Some discharge both treated and untreated wastes directly into waterways while others may unknowingly allow for runoff of contaminants into streams and rivers.

P.E.I. is not a heavily industrialized province and the effects of the industries which are present on the quality of her surface water resources are not widespread. However, there are various industries and industrial-related activities on the Island which present potential and real hazards to its water quality.

8.1 Stormwater Drainage (Runoff) Systems

Many municipalities on the Island have a stormwater drainage system in place consisting of either a comprehensive network or of only a few inlets and outlets. Effluents from these systems are not usually treated or monitored, except on occasion in the larger municipalities, before they are discharged into a surface water source.

The amount of pollutants contained in the stormwater runoff is dependent upon the location of the drains, the amount of industry within the drainage area, and whether or not the stormwater receives treatment prior to being discharged. Spring runoff and heavy rains yield the highest flow rates within the stormwater drainage systems.

Potential problems caused by untreated stormwater runoff

into surface water resources include sedimentation, nutrient enrichment and increased bacterial and chemical contamination.

8.2 Abandoned, Unapproved and Active Dump Sites

During 1982-83, the P.E.I. Department of Community and Cultural Affairs, in conjunction with Environment Canada, performed a study in which abandoned, unapproved and active waste disposal sites on Prince Edward Island were located and inspected (Water Resources Branch, 1983). Of prime concern was the potential for groundwater contamination. Other factors were also examined including proximity to water supplies and the types of wastes found at each site.

As part of the study each site was plotted on a map and a scoring system devised in order to rate and priorize (Priority I, II and III) them on the basis of actual and potential environmental effects.

Priority I sites were characterized by being within three hundred (300) metres of surface watercourses or private or public wells. Waste was usually in contact with or within five metres of the water table. Leachate was evident at all Priority I sites. Waste was predominately domestic but also included industrial, fishing and farming materials.

Priority II sites were either further from surface water or groundwater wells or did not indicate leachate production. Waste at these sites included such items as farm and fishing materials, household wastes, machinery metals and chemical containers.

Priority III sites were generally very small indiscriminate dump areas and were not considered to be environmentally hazardous. Types of waste found at these dumps would be similar to those found at Priority II sites.

Active bulk landfill sites do have guidelines concerning the type and amount of waste allowed for disposal. Since these dumps are staffed and have specific hours of operation it is easier to control the dumping of potentially dangerous materials. Type 3 wastes (industrial, animal and agricultural, sewage, sludges and chemical wastes) present a potential for water contamination and are accepted at these sites by permit only.

Local dump and container sites are not staffed. Thus, it is almost impossible to control or regulate the types of waste entering these areas. It is likely that all forms of refuse, in varying quantities, find their way into these sites. Container sites pose little threat to pollution of surface water resources since the lots are usually paved, the waste is

housed in large metal boxes and it is removed regularly to other landfill or dump sites. However, local dumps, especially those located close to streams or other waterways, will contribute to biological and/or chemical contamination of the aquatic system.

Water quality testing is performed at all approved waste disposal sites on P.E.I. both before the site is established and after the site becomes operational. Groundwater and surface water sources are tested for bacterial contamination and for indications of various chemicals such as calcium, nitrogen, phosphorous and sodium (Solid Wastes Management Branch, 1988).

There is not an established program for hazardous waste disposal on the Prince Edward Island (Curley, K., 1988). However, the Air and Solid Wastes Branch co-operates with their federal counterparts in controlling toxic waste disposal. For example, asbestos, which has been removed from buildings, is double-bagged and dumped at landfill sites. Agricultural pesticides and other chemicals, however, are sometimes left at dump sites by individuals who do not have permission to do so. Since it is difficult to control such practices, these remnant chemicals could become a potential hazard to both surface and groundwater sources. Therefore, even though there may be regulations in place they do not always have an effect on these practices.

Many common household products contain chemicals which are potential human health and environmental hazards. Improper disposal of these products can contaminate surface and groundwater supplies, destroy septic tank and sewage works organisims, contaminate soil and cause injury to sanitation workers who pick them up. In order to combat these problems, Environment Canada and the P.E.I. Department of Community and Cultural Affairs conducted a Household Hazardous Waste Collection Day as part of Environment Week 1988.

The public was invited to bring their hazardous household materials to six depots set up throughout the province. The collected wastes were then inventoried, sorted and packed with vermiculite into forty-five (45) gallon drums. These drums were then transferred to an off-Island disposal site. Approximately 150 people participated in the drop-off opportunity with fifty (50) containers of hazardous products being collected (LaVoie, 1988).

Another major form of toxic wastes in P.E.I. are polychlorinated biphenols (PCB's). As these compounds do not break down under normal conditions they must be stored until they can be transported to a proper disposal site which is located off-Island. Storage facilities are maintained

throughout the province. Additional information on PCB's is presented in Appendix C.

8.3 Sewage Treatment Plants / Lagoons

Many centers within P.E.I. have some type of sewage treatment system in place. Most often, the type of waste receiving treatment is domestic, but it may also originate as commercial or storm sewer discharge. Waste is treated to reduce organic and bacterial content. While not treated specifically for chemicals the processes do break down chemicals in some cases.

There are three types of lagoons in service within Prince Edward Island: total retention ponds (seasonal fill and draw), aerated and non-aerated ponds. The total retention ponds are not usually manipulated in any way except when the effluent has to be drawn off in order to prevent the lagoon from overflowing. Breakdown of wastes is the result of the presence of naturally-occurring bacteria. Before emptying the treated liquid from the lagoon the operators of the lagoon must receive permission from the Utilities Operation Branch of the P.E.I. Department of the Environment. The effluent is then tested before it is permitted to be pumped out of the lagoon (Reeves, 1988). As well, those who are involved with the cleaning of private or commercial septic systems may not dispose of the sewage within a minimum of 15.4 metres of a watercourse depending on the slope of the land [P.E.I. Environmental Protection Act, Sewage Disposal Regulations, Section 7(4)(c)(v)].

Problems occurring to the quality of groundwater or surface water usually result from the overflow and seepage of the facility as well as mechanical failure or leakage from broken pipes. Specific problems include nutrient enrichment, chemical and bacterial contamination, and an increase in the amount of organic materials to the receiving waters. This can lead to rapid plant growth, depletion of oxygen levels and odour problems.

8.4 Rail Line Activity

Earlier this century railroads on Prince Edward Island were a vital component in the transportation of goods. However, due to increased costs and more efficient trucking methods, its importance rapidly decreased. Rail service was gradually phased out over the years and in January 1990, the last train left the Island. Freight which was transported included lumber, feed grains, various food items, vegetable oil, fertilizers and their components (potash, diammonium phosphate (D.A.P.) and ammonium nitrate), as well as various hazardous products such as lube oil, aviation fuel and propane.

Once rail lines were abandoned, Canadian National Real Estate contracted out for the removal of the rails and ties. It is specified in the contract whether or not the bridges and other major road or stream crossings are to be taken out. They are not usually removed since the costs of doing so are fairly high and the structures are often more useful if left in place. The P.E.I. Government recently agreed to purchase a substantial amount of land which resulted from abandonment of the rail lines (The Guardian - Patriot, 1988). What will happen to these lands as a result of the abandonment process is currently being reviewed with the following options under consideration:

1. transfer it to those farmers whose lands are divided by the lines, and/or
2. convert them to recreational trails for snowmobiling, hiking and cycling.

Threats to surface water resources as a result of rail line abandonment include; sedimentation resulting during line removal, destabilized banks, and instream obstructions as a result of the discontinuation of regular rail-stream inspections and maintenance.

8.5 Excavation Pits

Scattered throughout P.E.I. are numerous excavation pits used for the private or commercial removal of sandstone and to lesser amounts, gravel and sand. All operational pits require government approved excavation permits issued by the Environmental Management Division, P.E.I. Department of the Environment. Not only pit owners, but also excavation contractors, are bound by law to ensure that a valid permit is in force. No records are maintained concerning the quantity of material removed from individual pits.

Regulations are in effect which require that the pits not be located within thirty (30) metres of a surface waterway. Once abandoned owners of the pit are required to stabilize the slopes and reseed the area. Permanent pits must have a 2:1 slope while temporary pits require a 3:1 slope (Murphy, C., 1988).

Threats to surface water quality due to the operation of excavation pits include increased sedimentation rates and chemical contamination resulting from the presence of heavy machinery.

8.6 Salt / Sand Storage Locations

The P.E.I. Department of Transportation and Public Works maintains a number of salt/sand storage depots across the

Island. Often the locations of these change annually thereby yielding both abandoned and active sites.

In addition to providing protective housing for salt storage there are also larger depots located at various sites across the Island which also serve as a mixing area for the salt and sand which is then transfered to the smaller local sites. At these secondary locations the salt/sand mixture is stored directly on the ground with little or no site preparation. Thus, there exists the possibility of salt intrusion into both surface water and groundwater sources.

During the winter of 1987-88 there were 60,380 tonnes of blended material (consisting of 73.5 percent local sand, 20 percent crushed stone and 6.5 percent salt) and 21,813 tonnes of salt spread on P.E.I. roads in order to combat road-ice problems. There is, depending on the severity of the winter, a 2 to 3 percent surplus af material annually (Cairns, 1988).

Additional threats to the quality of surface water resources caused by the presence and operation of these salt/sand storage depots include sedimentation and chemical contamination due to the presence of heavy machinery.

8.7 Snow Disposal Sites

Snow which falls on municipalities is most often removed from the area after the streets have been plowed. The snow is trucked to specific disposal sites which, in some cases, may be directly into a surface water source. The detrimental effects of this practice on the quality of surface water resources are dependent upon from where the snow was removed. For example, snow removed from a sparsely populated area would have less impact on the water quality than snow removed from an industralized or downtown urban area.

Problems arising from disposal of snow near or into a surface water source include flow inhibition and increased sedimentation resulting from the sand mixed with the snow. Additional problems include increased nutrient content and bacterial contamination due to debris picked up with the snow from the roads and parking lots. Road salt runoff in fresh water systems can also lead to problems with build-up and the loss of finfish spawning beds and aquatic insects (Currie, 1989).

9.0 ALTERATIONS OF NATURAL FEATURES OF WATERWAYS

Individuals or groups wishing to alter a water system directly (dam construction and pond creation) or indirectly (excessive cutting or removal of trees) to improve the recreational potential, to provide a reservoir for agricultural

use or fire prevention or to construct a stream crossing, must seek approval from the P.E.I. Department of the Environment (P.E.I. Environmental Protection Act, Sections 10 and 11).

9.1 Application Process and Requirements

Watercourse alteration applications are subject to government control under the P.E.I. Environmental Protection Act (Section 10) and the Canada Fisheries Act (Section 20). Before requests are given final approval by the Head of the Watercourse Alteration Advisory Committee, they are reviewed by numerous Federal/Provincial government and private agencies, namely:

- Water Resources Branch, P.E.I. Department of the Environment;
- P.E.I. Department of Energy and Forestry;
- Fish and Wildlife Branch, Department of the Environment;
- P.E.I. Department of Fisheries;
- P.E.I. Department of Transportation and Public Works;
- Department of Fisheries and Oceans Canada; and the
- University of Prince Edward Island.

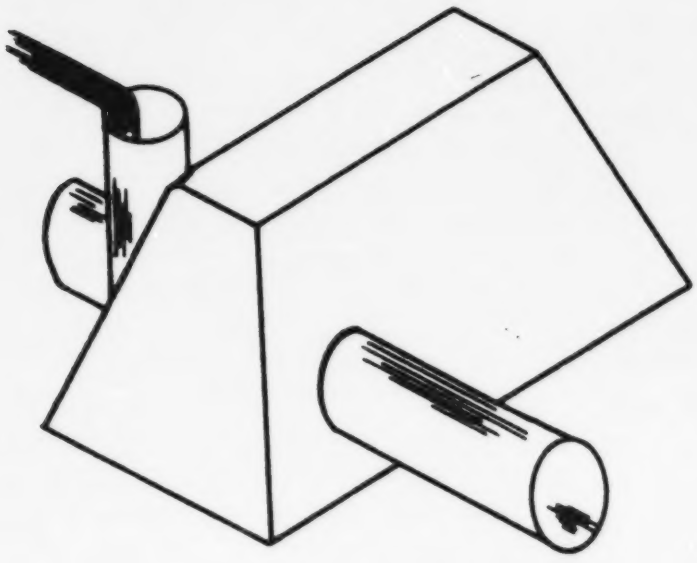
Once approval is given, regular inspections are performed to ensure that the recommendations of the above agencies are being properly followed. If not, the necessary repairs are done by the appropriate agency at the applicant's expense.

Criteria for evaluating the applications include (Water Resources Branch, n.d.):

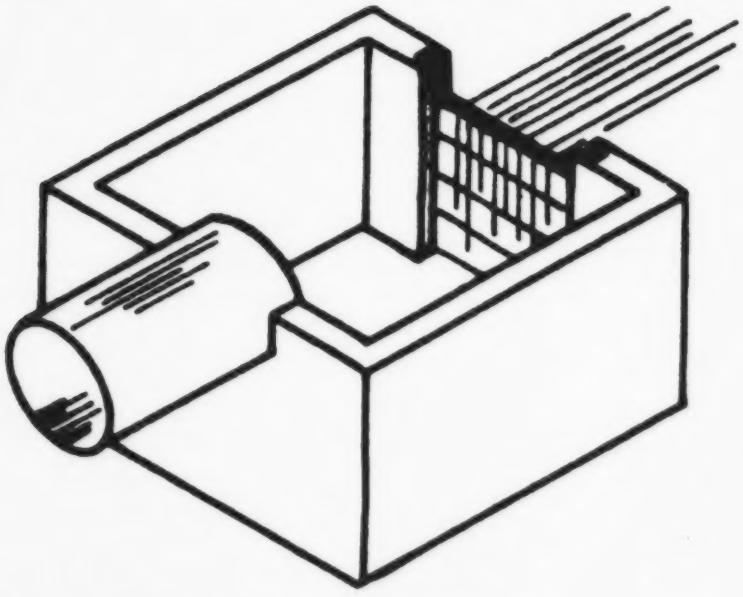
1. the well being of the fishery resource (primary);
2. possible changes in water quality;
3. stream-side cutting leading to loss of essential food and cover;
4. the effects of the alteration on other types of wildlife (waterfowl and furbearing animals).

The Soil and Crop Division of the P.E.I. Department of Agriculture evaluates the dam and pond applications on the basis of construction detail, engineering aspects, extent of flooded area, dimensions and locations of the ponds and the agricultural potential of the area.

New dams must have fishways and water control structures which will enable drawdown of the resulting pond without causing damage to the water systems below. If a watershed size is less than 2.5 square kilometres there is not enough water to provide fish passage and the application is usually turned down (Currie, 1989). Water control structures commonly are of the vertical standpipe or concrete stoplog type (Figure 9.1), while fishways on the Island are of the Denil, vertical slot, pool-



VERTICAL STANDPIPE



CONCRETE STOPLOG

Figure 9.1 Water Control Structures

and-weir or baffled channel varieties (Figures 9.2, 9.3, 9.4 and 9.5).

By-pass ponds are often constructed for agricultural purposes and can be of two types. Figure 9.6 illustrates a proper design (does not dramatically alter the natural course of the waterway) and an improper design which leads to problems with excessive weed growth and siltation therby negatively impacting on fish habitat.

Other watercourse alterations include which may be applied for include:

1. roadway culvert installation, which must provide for fish passage (Figure 9.7);
2. rock gabion deflectors, which create improved habitat for fish in terms of resting (pool) areas (Figure 9.8);
3. infilling, which is not usually approved as it results in a loss of wildlife habitat; and
4. for stream-side and instream improvement.

Since Island soils are highly susceptible to erosion, proponents who alter streams must undertake erosion control measures immediately upon completion of the proposed alteration.

9.2 Dam Inspections

In P.E.I. the construction, modification and repair of dams is considered to be a watercourse alteration. Therefore, both federal and provincial approval is required before such work can be performed. The P.E.I. Government is concerned with water quality while the federal government is interested in the conservation of the fisheries resource and the protection of fish habitat.

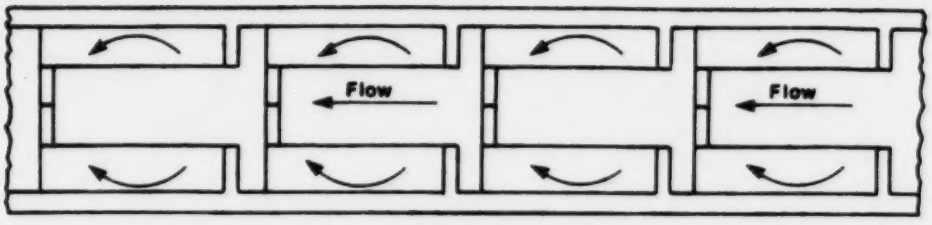
All dams from previous inventories located within the Watershed Inventory Project's boundaries were identified. Most were field checked in order to determine their condition and whether or not they constituted a barrier to successful fish passage.

9.3 Fishways

Whenever an alteration is made to a stream the continued passage of fish must be ensured (Canada Fisheries Act, Section 20). Various types of fishway designs are available with the design used dependent upon the species of fish to be passed and the water level fluctuations within the impoundment.

On-site conditions beyond design limits or insufficient attraction of fish to the fishway commonly restricts passage success. The pool and weir configuration offers the highest

DENIL FISHWAY



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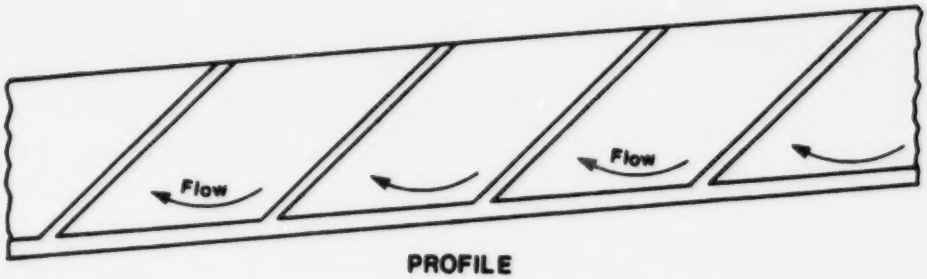

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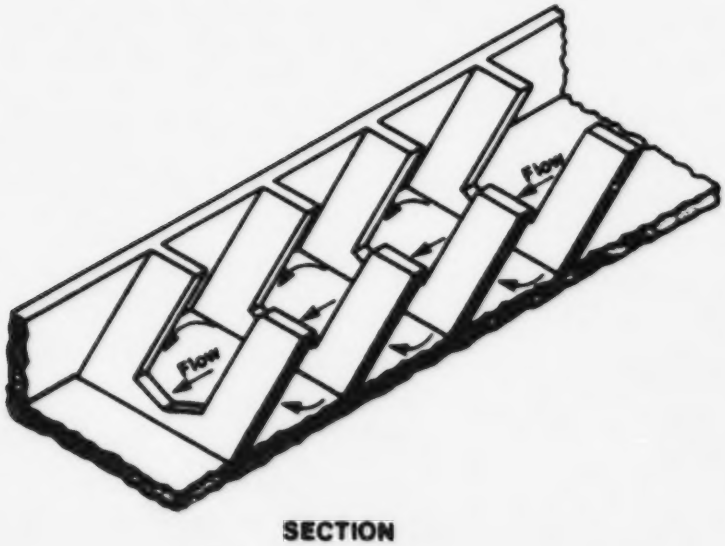
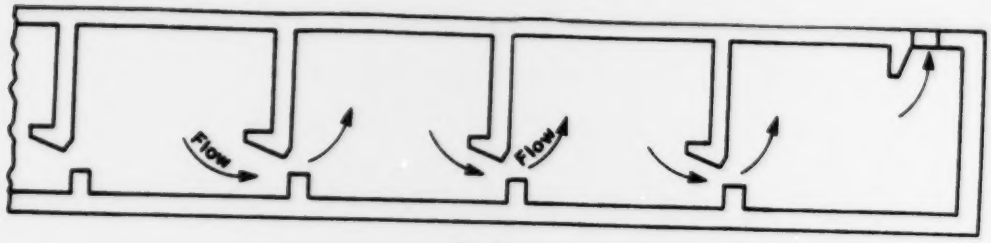


SECTION

Figure 9.2 Denil Fishway

VERTICAL SLOT FISHWAY



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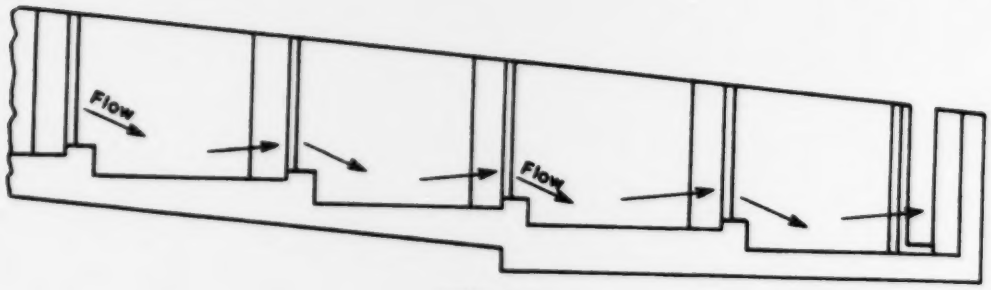

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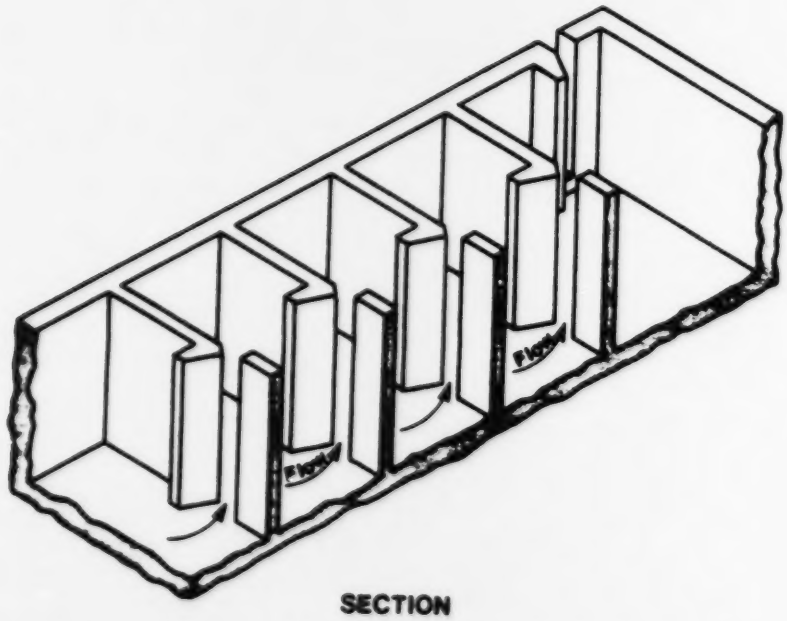

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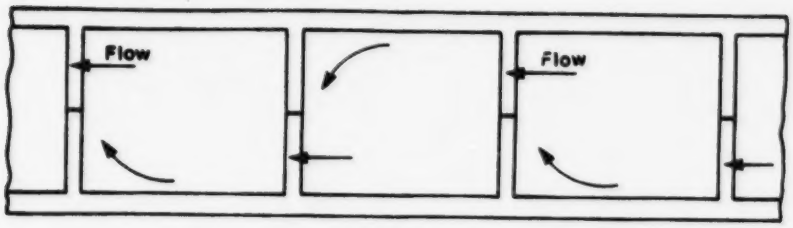
Figure 9.3 Vertical Slot Fishway

POOL AND WEIR FISHWAY



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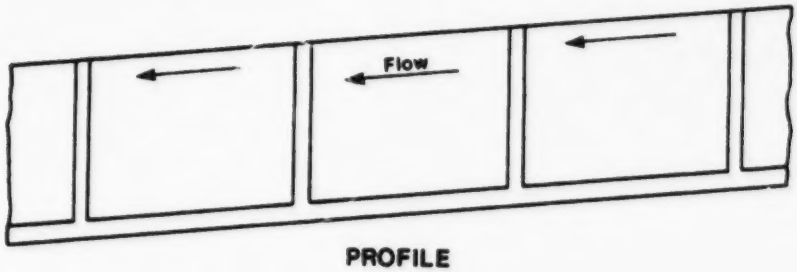

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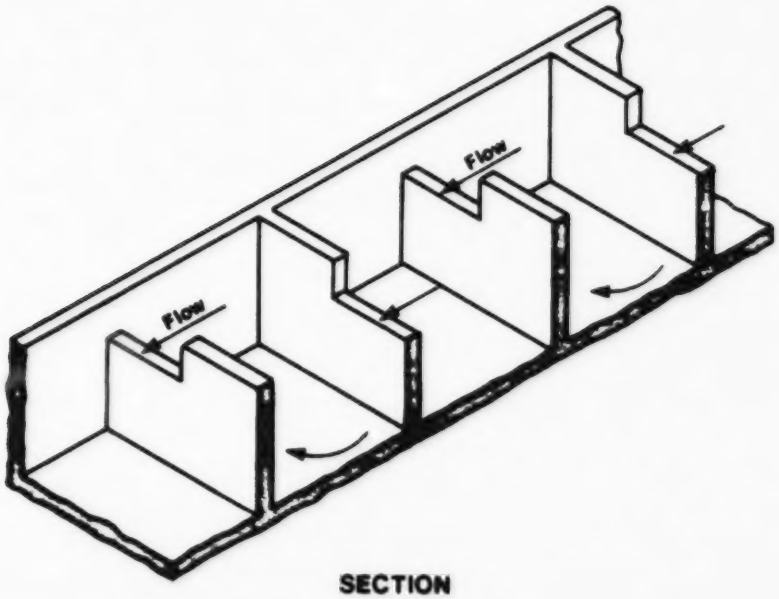

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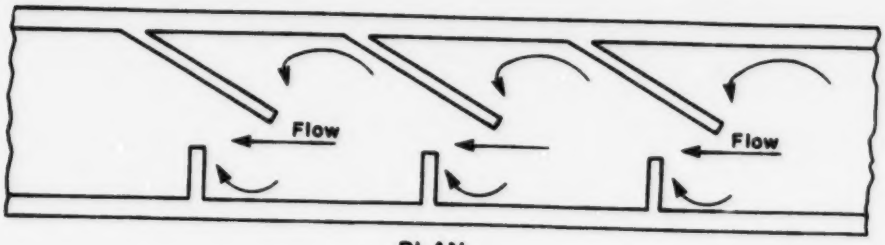
Figure 9.4 Pool and Weir Fishway

BAFFLED CHANNEL FISHWAY



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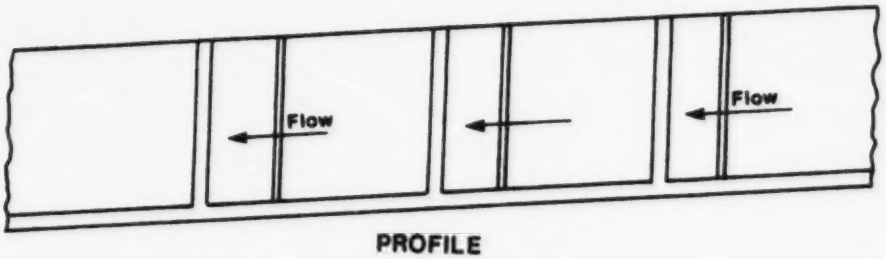

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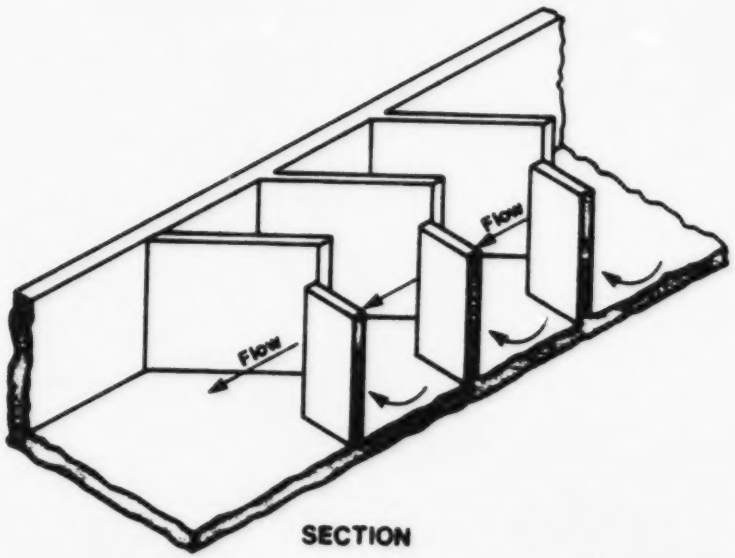

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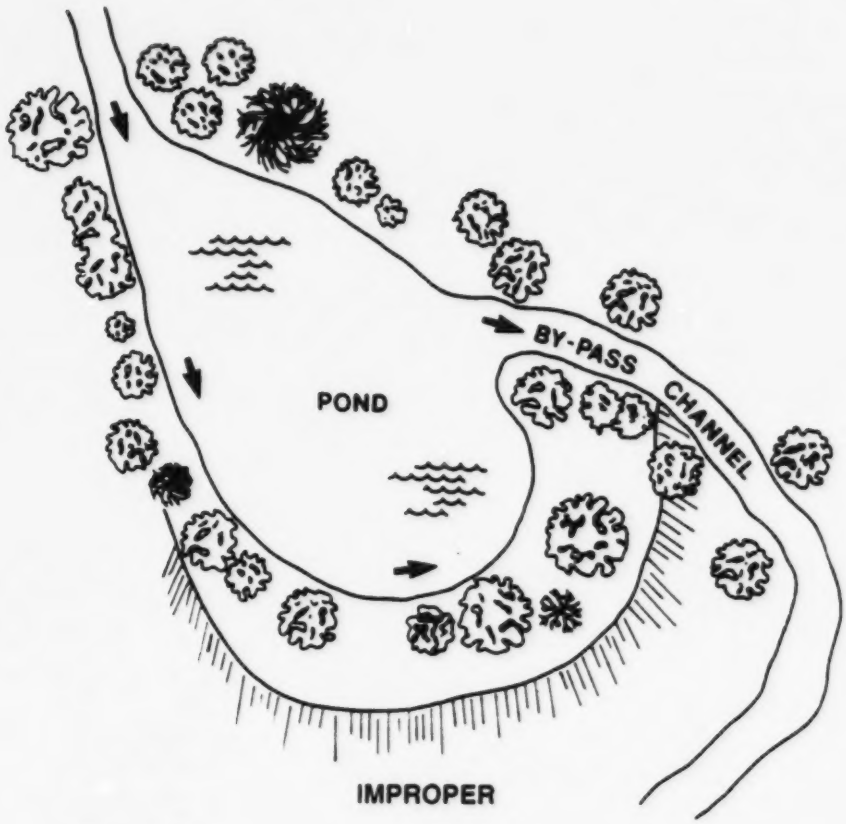
Figure 9.5 Baffled Channel Fishway

BY-PASS POND CONSTRUCTION



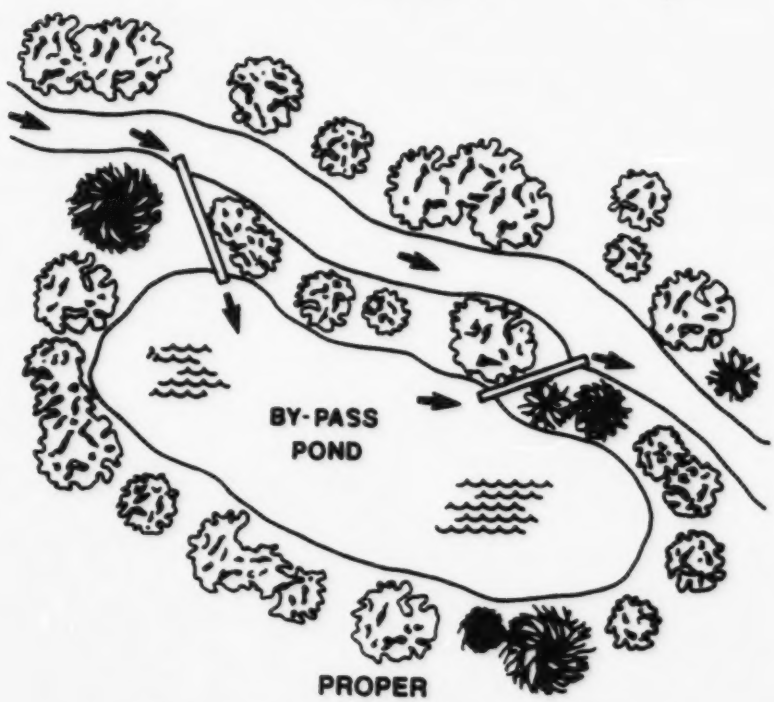


Figure 9.6 By-Pass Pond Construction

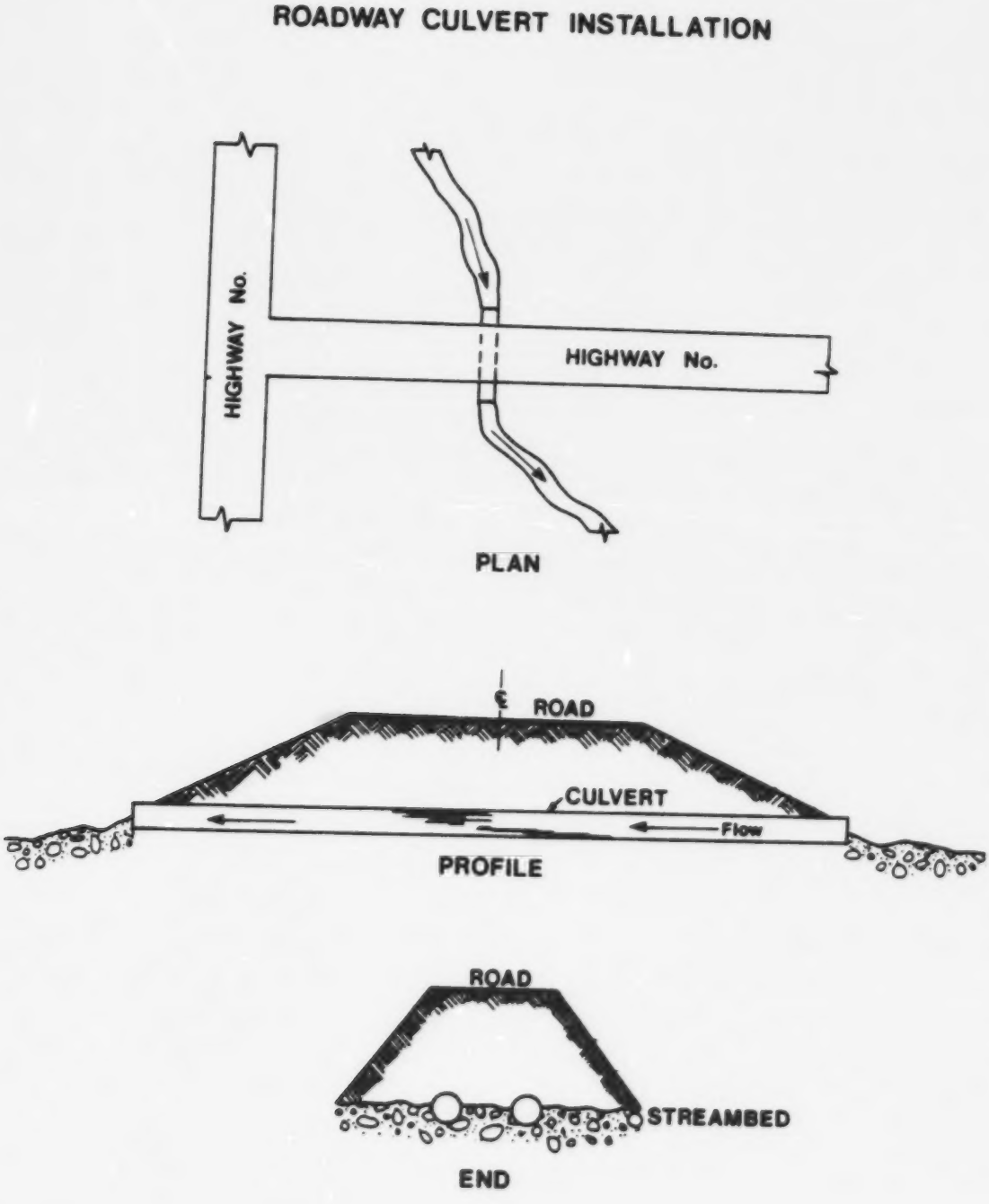


Figure 9.7 Roadway Culvert Installation

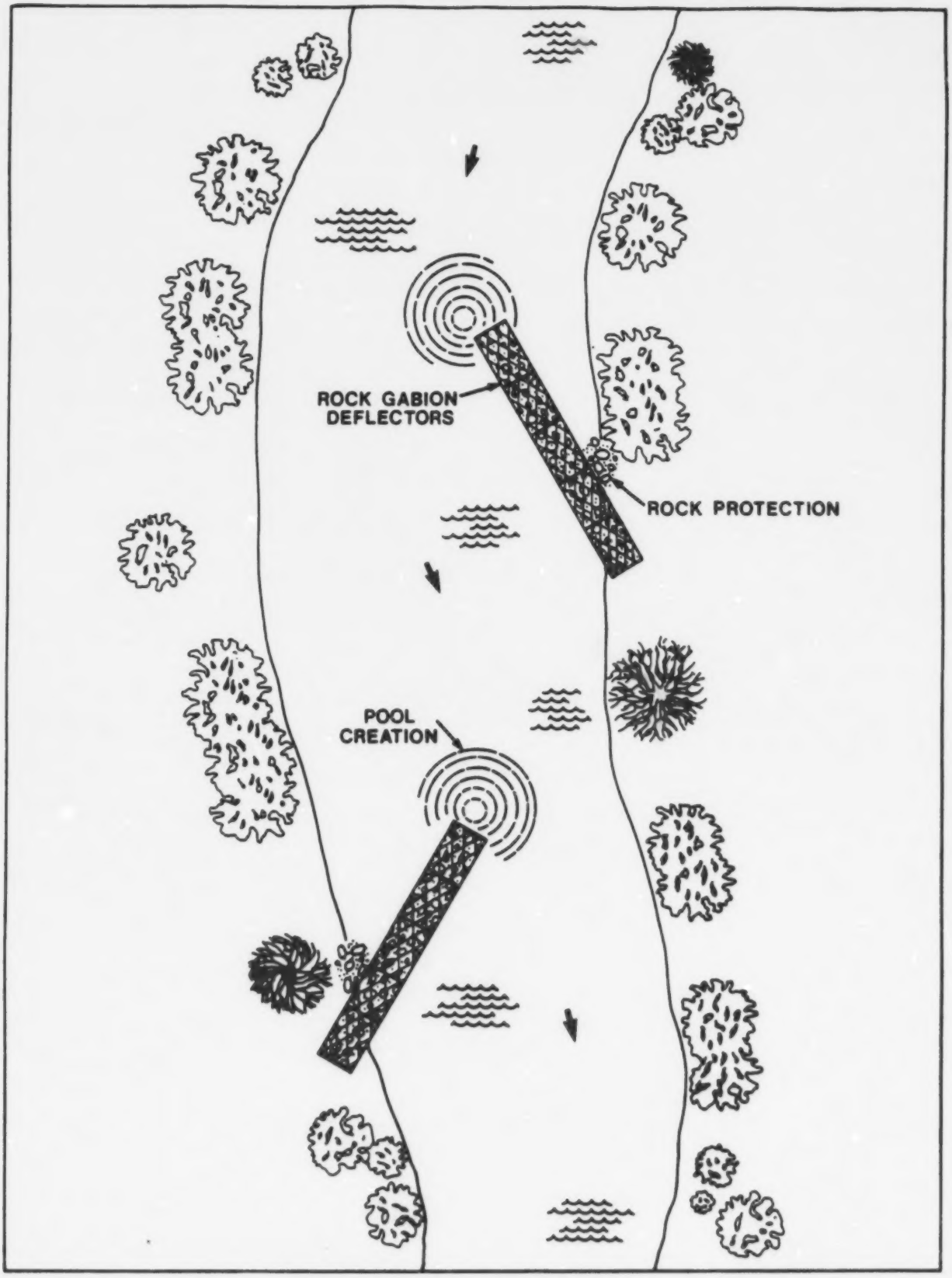


Figure 9.8 Rock Gabion Deflectors

potential for the successful passage of fish in P.E.I. Vertical slot fishways are installed when large fluctuations of water level are anticipated.

9.4 Road - Stream Crossing Structures

All road-stream crossing structures used by the P.E.I. Department of Transportation and Public Works must be approved by the Watercourse Alteration Advisory Committee. There are several types from which to choose (causeways, bridges, box culverts, round culverts and pipe arches). The type of road-stream crossing structure to be installed should be in accordance with various design criteria such as required flow, capacity, slope depth of water within the structure, the length of the crossing and the shape of the structure.

Although the P.E.I. Department of Energy and Forestry recommends culverts of a maximum of 0.76 metres (30 inches) to be installed for a normal stream crossing, properly engineered culverts of a larger size can be installed (Humes, 1989).

A major problem associated with many road-stream crossing structures which were previously installed lies in the fact that culverts are often set to too high a grade, thus rendering the structure a barrier to successful fish passage. In theory grades should not exceed 0.5% and the culverts should be set at least fifteen (15) centimetres into the streambed (Humes, 1989). Some of the improperly installed structures have been corrected through the creation of baffled channels within the culvert. This allows for a decrease of water velocities and an increase in the water depths within the crossings.

Other adjustments which can be made to ensure the successful passage of fish through road-stream crossings include creating a plunge pool (area directly below its entrance) depth of no less than 1.25 times the height of the jump and allowing for a minimum water depth of twenty-three (23) centimetres within the structures (Ontario Ministry of Natural Resources, n.d.).

The P.E.I. Department of Transportation and Public Works maintains a reference map which provides an up-to-date record of all major highway structures, that is, those over 120 centimetres in diameter. Additional data such as overall span, centerline height above streambed, centerline of roadway, type, description and condition for each of these road-stream intersections is also available from the Department of Transportation and Public Works.

The Watershed Inventory Project has also identified all other road-stream intersections within the study watersheds.

These areas were located using 1:50,000 N.T.S. topographical maps but not all are being field checked due to limited time and manpower.

9.5 Rail - Stream Crossing Structures

As mentioned previously (Section 8.4), all rail lines across the Island have been abandoned effective January 1990. As the lines undergo abandonment the rails and ties are removed but the crossing structures are usually left in place since they are often more useful and the costs of removing them are quite high.

Regular inspection and maintenance of rail-stream intersections will cease as the lines are abandoned and removed. This will present problems in the future in terms of fish passage and siltation of the waterways. Those lines which undergo conversion to recreational trails will, most likely, have regular inspections and maintenance carried out but those lines which are turned back over to the people whose lands were divided by them may not.

10.0 WETLANDS

Wetlands include salt marshes, intertidal flats, bogs, freshwater marshes, swamps and small ponds. They are important for many reasons (Canadian Wildlife Service, n.d.):

1. as habitat for wildlife;
2. act as natural filters (protecting water quality downstream);
3. bind pollutants such as nitrates and phosphates thereby retarding the eutrophication of downstream waters;
4. reduce flooding and erosion by storing water and stabilizing stream flow;
5. recharge groundwater supplies and act as natural firebreaks.

During 1983-84 Prince Edward Island wetlands over 0.25 hectares in size were inventoried during a joint federal-provincial venture with additional assistance from Ducks Unlimited Canada. The overall objective of the program was to provide information on the size, classification, distribution and wildlife values of freshwater and coastal wetlands located within the province.

10.1 Freshwater Wetlands

All freshwater wetlands within Prince Edward Island were identified during the 1983-84 inventory. They were also given a wildlife value based on a wide array of parameters including;

water chemistry, wetland juxtaposition, size, topographic features and hydrology, surrounding habitat and proportions and interspersions of cover and water. All freshwater wetlands were then given a score ranging between 36 and 108 with those scores at 60 or more indicating generally more productive areas. Scoring methodology is described in the publication Wetlands Atlas of Prince Edward Island which is available at the P.E.I. Fish and Wildlife Branch's office in Charlottetown (Canadian Wildlife Service, n.d.).

10.2 Coastal Wetlands

Coastal wetlands were classified and scored as coastal units. The coastal unit score was calculated from the total of the scores from six component types (salt marshes, coastal saline ponds, estuarine flats, beaches, dunes and islands) along with five conditional factors (tidal influence, vegetation presence, size, exposure factor and juxtaposition factor) and added to that was a value for the disturbance status of the coastal unit. The total coastal unit score is an indication of its productivity and also provides a measure of its importance to wildlife. The total coastal unit scores ranged from 10 to 1500 points which is a representation of the sum of all individual wetland scores within the unit.

10.3 Ducks Unlimited Canada Management Sites

Ducks Unlimited Canada (D.U.) is active on Prince Edward Island in the development and improvement of wetlands using a variety of management techniques. Installation of water control devices such as drop inlets and stoplog control structures enable the regulation of water levels within the impoundment. Fishways are often installed along with the water control structures in order to allow for the continued passage of fish into and out of the impoundment. Other habitat management techniques employed by D.U. on P.E.I. include vegetative transplantation, and in excessive blocks of vegetation, the creation of open water by mechanical means such as level ditching.

D.U. has sponsored some seventy-four (74) wetland enhancement projects on the Island totalling 2336 hectares (Canadian Wildlife Service, n.d.).

11.0 ADDITIONAL WATERSHED ACTIVITIES

There are many unique activities being carried out in specific watersheds across the province. These will be discussed in more detail in the individual watershed reports. However, common activities such as hydrometric stations/water chemistry data and subdivision development are discussed more

fully below.

11.1 Hydrometric Stations / Water Chemistry Data

In 1919 an initial agreement was reached between the Water Survey of Canada and the Province of Prince Edward Island which called for basic water resources studies. The hydrometric stations which were subsequently established were to monitor flow rates for specific rivers. They supply data such as daily discharge, maximum and minimum daily flow and average flow. Although the initial Agreement ended in 1933, a new accord was begun in 1961.

Physiographic characteristics for the basins draining to each of the hydrometric stations have been determined by the Inland Waters Directorate, Environment Canada, Dartmouth, Nova Scotia. Presently (1990), there are thirteen (13) hydrometric stations operational in P.E.I. although there are records available for the thirty-four (34) stations which have been in operation for various periods since 1919 (Table 11.1). Figure 11.1 shows the locations of the hydrometric stations located on P.E.I. showing at least five years of record.

In addition, the Water Quality Branch, Inland Waters Directorate, Environment Canada, Moncton, New Brunswick, maintains somewhat limited data associated with the following studies:

- P.E.I. Groundwater Study (May 1982 - September 1973),
- P.E.I. Surface Water Quality Survey (July 1972),
- Water Quality Board National Water Quality Monitoring (April 1974 - March 1978),
- Charlottetown Airport Expansion Study (September 1976 - 1985), and the
- Toxic Chemical Survey (1985).

Parameters monitored at individual water chemistry stations may include the following: major ions, physical parameters, nutrients, metals and toxic substances.

As part of the Surface Water Program, a hydrologic study of P.E.I. was conducted through Inland Waters Directorate, Environment Canada, Dartmouth, Nova Scotia. The resulting streamflow information will be useful in supplying data for the design of dams, bridges and culverts, for the planning of water supplies, navigation channels and fisheries resources, for floodplain delineation and to assist in environmental protection (Inland Waters Directorate, 1989).

11.2 Subdivision Development

There is a trend on Prince Edward Island in which people

Table 11.1 Physiographic Data at Hydrometric Stations Within P.E.I.

Station Number	Watershed	Drainage Area (km^2)	Forest Area (km^2)	Cleared Area (km^2)	Swamp Area (km^2)	Pond Area (km^2)	Basin Perimeter (km)	Total Length of Stream (km)	Stream Gradient (%)	Period of Record
01CA001	MILL-TROUT	40.30	25.00	13.30	1.90	0.0	25.60	34.40	0.33	1919-1922
01CA002	TROUT RIVER	21.60	12.60	8.90	0.14	0.0	18.30	20.70	0.37	1919-1922
01CA003	MILL-TROUT	48.00	27.20	18.80	2.00	0.0	33.20	42.60	0.32	1961-PRESENT
01CA004	SMELT CREEK	17.60	10.70	6.80	0.16	0.0	16.70	12.40	0.46	1967-1974
01CB001	DUNK-WILMOT	99.80	28.00	71.50	0.05	0.26	46.40	98.10	0.29	1919-1933
01CB002*	DUNK-WILMOT	115.00	30.10	84.50	0.13	0.26	50.90	101.00	0.27	1961-PRESENT
01CB003	MALPEQUE BAY	4.90	0.40	4.50	-	0.006	10.30	3.70	0.73	1970-1982
01CB004*	DUNK-WILMOT	46.00	6.30	39.60	0.06	0.088	33.83	51.30	0.36	1972-PRESENT
01CB005	DUNK-WILMOT	12.90	1.30	11.40	0.08	0.064	16.90	11.90	0.44	1971-1987
01CB006*	DUNK-WILMOT	5.60	1.20	4.40	0.0	0.001	9.53	6.30	0.68	1974-PRESENT
01CB007	DUNK-WILMOT	10.90	4.20	6.70	0.0	0.02	13.50	9.30	1.11	1974-1975
01CB008	DUNK-WILMOT	20.00	10.00	9.90	0.01	0.018	19.50	19.80	0.88	1974-1975
01CB009	DUNK-WILMOT	53.30	19.80	33.50	0.02	0.044	33.70	48.10	0.51	1974-1975
01CB010	DUNK-WILMOT	16.30	4.10	12.10	0.01	0.001	17.80	19.40	0.89	1974-1975
01CB011	DUNK-WILMOT	80.70	25.60	55.00	0.03	0.046	41.00	79.90	0.37	1974
01CB012	DUNK-WILMOT	8.20	0.70	7.50	0.02	0.00	12.50	7.90	0.75	1974-1975
01CB013	DUNK-WILMOT	99.60	27.90	71.40	0.05	0.256	45.90	97.80	0.34	1974
01CB014	DUNK-WILMOT	23.50	8.20	15.30	0.002	0.013	24.80	18.20	0.38	1974-1975

...continued

Station Number	Watershed	Drainage Area (km^2)	Forest Area (km^2)	Cleared Area (km^2)	Swamp Area (km^2)	Pond Area (km^2)	Basin Perimeter (km)	Total Length of Stream (km)	Stream Gradient (%)	Period of Record
01CC001	RUSTICO	42.70	18.10	24.50	0.002	0.044	29.10	35.40	0.69	1919-1922
01CC002*	TRACADIE	37.40	14.80	22.00	0.30	0.316	33.40	25.00	0.24	1967-PRESENT
01CC003*	TRACADIE	4.40	0.70	3.70	0.0	0.015	8.00	2.30	0.46	1968-PRESENT
01CC004	HILLSBOROUGH	2.10	0.20	1.90	0.003	0.0	6.20	1.40	1.83	1976-1979
01CC005*	HILLSBOROUGH	70.20	34.60	35.60	0.002	0.021	40.20	78.80	0.40	1988-PRESENT
01CC006*	HILLSBOROUGH	27.20	4.80	22.40	0.03	0.004	22.10	22.60	0.57	1989-PRESENT
01CD001	ST. PETERS BAY	134.80	85.40	43.80	4.90	0.649	67.60	113.80	0.24	1919-1921
01CD002	ST. PETERS BAY	130.60	82.30	42.70	4.90	0.649	67.60	110.30	0.25	1961-1979
01CD003*	ST. PETERS BAY	148.80	92.80	50.30	5.09	0.659	68.50	120.70	0.22	1964-PRESENT
01CD004*	BOUGHTON-PORTUNE	22.90	-	-	-	-	-	-	-	1988-PRESENT
01CE001	VERNON RIVER	17.20	8.90	8.20	0.02	0.007	19.30	10.70	0.43	1919-1933
01CE002	MONTAGUE-VALLEYFIELD	50.30	26.70	23.50	0.07	0.01	43.10	41.90	0.38	1919-1933
01CE003	BRUDENELL-CARDIGAN	36.30	14.20	21.10	0.78	0.148	25.70	32.80	0.54	1965-1979
01CE004*	BRUDENELL-CARDIGAN	33.80	13.60	19.30	0.75	0.125	24.20	29.80	0.55	1979-PRESENT
01CE005*	MONTAGUE-VALLEYFIELD	43.30	23.30	19.80	0.07	0.01	41.50	37.00	0.39	1987-PRESENT
01CE006*	CARDIGAN-BRUDENELL	21.40	-	-	-	-	-	-	-	1988-PRESENT

* ACTIVE

Figure 11.1 Meteorologic Stations and Hydrometric Stations With At Least Five Years of Record

are relocating from urban settings to suburban or rural areas. This often results in the creation of new residential areas or subdivisions. There are many negative effects on the quality of surface water resources as a result of this development.

Initial clearing, grading and construction of roads for subdivisions causes increased sedimentation, nutrient enrichment and bacterial content in the water thereby degrading fish habitat. Other problems which may occur include chemical contamination caused by the presence of heavy machinery and an increase in the amount of organic materials in rivers and streams. A major side effect is the alteration or blockage of waterways during the construction phase. Therefore, proper precautions should be followed to guarantee the protection of surface waters while construction is being carried out.

Related to the construction phase is the infilling of wetlands in order to have suitable lands to develop. Since wetlands are rendered useless by this practice the possibility of increased sedimentation and contamination of the waterways exists. A measure is in place in P.E.I. which protects against the loss of marshes and swamps during construction activities [P.E.I. Environmental Protection Act, Section 10(b)(c)(d)].

Septic systems for new developments must be installed in accordance with the Sewage Disposal Regulations under the P.E.I. Environmental Protection Act. For example, a septic tank may not be located nearer than 15.4 metres from a groundwater or surface water source that is fit for human consumption [Section 4 (1)(a)]. An absorption field shall not be located in an area where the groundwater or watercourse is less than 1.2 metres below the ground surface at any time [Section 5(1)]. As well, the absorption field shall be located not less than 15.4 metres from any source of water fit for human consumption [Section 5(3)(c)] or 15.4 metres from a natural body of water [Section 5(3)(d)].

Bacterial and chemical contamination of surface waters can also result due to a variety of other subdivision-related activities such as sewage system malfunctions, stormwater drainage and snow clearing operations.

12.0 ACTIVITIES AFFECTING SURFACE WATER RESOURCES WITHIN PRINCE EDWARD ISLAND

Many of the activities affecting the quality or quantity of surface water resources within the province occur as a result of the high erodibility of Island soils. Formed by the breakdown of underlying sedimentary bedrock, the topsoil is especially prone to destabilization by natural weathering. Erosion is accelerated by poor agricultural, forestry and road

construction and maintenance practices. The problems affecting surface water resources on P.E.I. fall into three general categories: sedimentation (siltation) sources, pollution point sources and instream obstructions.

12.1 Sedimentation (Siltation) Sources

The entry of soil into surface waterways is described by the Watershed Inventory Project as a sedimentation (siltation) source. Autumn tillage, particularly plowing with the slope and cultivation excessively close to the streams' edge, often results in extensive landwash and siltation of the Island's waterways. Improper forestry operations, such as clearcutting on steep slopes and removal of greenbelts along streams and rivers, also provides for sedimentation of streams and rivers.

One of the major sources of siltation to Island waterways is caused by the construction and maintenance of P.E.I. roads. Many roads on the Island are unpaved which presents numerous potential sources of sedimentation. Improper grading of these roads, in particular, leaving a ridge of clay and sand at either edge allows runoff water to form channels causing erosion to the road surface. Water usually flows alongside these ridges until it "breaks" through, usually at a road-stream intersection. This practice of grading also renders ditches, if present, useless.

Silt-loading of Island streams and rivers does not usually affect the waterway at the point of entry but its effects are impacted further downstream. Soil particles are carried by currents and deposited in the stream covering essential finfish spawning areas. Shellfish beds within the estuaries at the mouth of the rivers and streams are adversely affected since they are smothered by the silt that has originated from upstream locations.

12.2 Pollution Point Sources

The entry of non-natural substances into a surface waterway is known as a pollution point source. For example, fertilizer and manure runoff into surface waterways results in bacterial and chemical contamination of the system. Inadequately or improperly treated human sewage, stormwater drainage and the discharge of industrial effluents also contribute to the deterioration of P.E.I.'s surface water quality.

The most recent examples of pollution point sources on the Island have been the entry of petroleum products, specifically gasoline, into streams, rivers and groundwater aquifers. This has resulted from either transportation accidents or leakage

from underground storage tanks.

In many cases the result of these pollution point sources is the eutrophication of the aquatic system. As is the case with siltation the effects of many pollution point sources are felt in downstream areas. This can, for example, result in the closure of shellfish harvesting areas as is evident in many estuaries across the Island.

12.3 Instream Obstructions

Numerous other factors also influence the quality of Prince Edward Island's waterways. Fallen trees or other debris in the streams and rivers present problems for fish passage. Improperly installed culverts, insufficient water flow and non-existent or inadequate dam bypass structures not only pose barriers to successful fish passage but also affect the amount of water available for use in downstream areas by other proponents.

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APPENDICES

APPENDIX A

COMMONLY USED PESTICIDES

USE PERIOD	PESTICIDES
May	Disulfoton, aldicarb -- granular insecticides applied at planting only.
June	Herbicides -- 2,4-D, MCPA, metribuzin, chlorbromuron, paraquat, linuron, dinoseb, atrazine, alachlor, cyanazine.
July	Fungicides -- mancozeb, metiram, chlorothalonil, captafol. Insecticides -- endosulfan, carbofuran, azinphos-methyl.
August	Fungicides -- As listed for July. Insecticides -- As listed for July, oxdemeton-methyl, pirimicarb, dimethoate, methamidophos.
September	Fungicides -- As listed for July. Herbicides -- diquat, dinoseb.

APPENDIX B

GUIDELINES FOR CULL POTATO BURIAL PROGRAM*

The following shall constitute a proper burial site:

1. Site shall be located at least 154 metres from any surface water and from any private well or water supply.

2. A site shall also be located downslope of any water supply and preferably near a groundwater discharge area.

3. Burial should not occur within 0.62 metres of the bedrock surface or water table. The excavation should be inspected before cull potatoes are placed. If bedrock has been exposed before the exposure should be covered with a minimum of 0.62 metres of compacted overburden material before potatoes are placed. If springs or seepages are encountered or if the pit shows other indications of having been deepened below the water table the site should be abandoned.

4. The burial site should be suitably graded upon completion to promote run-off of water away from the burial site.

5. All proposed burial sites for quantities of 450,000 kilograms and over shall be approved by a representative of the Water Resources Branch, P.E.I. Department of the Environment prior to use.

6. Proposed burial sites for any quantities in suspected environmentally sensitive areas shall be referred to the Water Resources Branch, P.E.I. Department of the Environment prior to use.

* Recommended by the P.E.I. Department of the Environment, 1988. Adopted by P.E.I. Department of Agriculture, 1989.

APPENDIX C

POLYCHLORINATED BIPHENOLS (PCB's)

Polychlorinated biphenols (PCB's) are synthetic chemical compounds consisting of chlorine, carbon and hydrogen. Various brand names include Aroclor, Pyranol, Inerteen, and Hyvol. Their resistance to chemical and biological breakdown by natural processes in the environment make them especially hazardous. PCB's can only be destroyed under conditions of extreme heat (1200°C) or in the presence of certain combinations of chemical agents and heat.

Polychlorinated biphenols serve a variety of industrial uses ranging from hydraulic fluids and surface coatings for carbonless copy paper to plasticizers in sealants, caulkings, rubbers, paints and waxes. Their major use, however, is as a cooling and insulating fluid for eletrical transformers and capacitors.

Prince Edward Island has 14.9 tonnes of PCB's including 0.8 tonnes in storage (1985 figures). The rest is being used for electrical purposes. PCB's are environmentally hazardous due to:

1. their persistence (virtually all of the PCB's that have entered the environment thus far are still there);
2. their bioaccumulation (they are soluble in an organic medium such as fat tissue, but are insoluble in water. For this reason, PCB's are accumulated as they move up the food chain;
3. their dispersal through the atmosphere (showing up in areas far from industrial activity);
4. their toxicity (an acceptable level of PCB's in the environment is 5parts per million (ppm) whereas most industrial-use PCB's have a level of 50 to 16,000 (ppm) (Haywood, 1988).

Although their effects on human health are not fully understood, Canada restricted the use of PCB's to closed systems in 1977. There is now a phase-out through natural attrition underway. There have also been new regulations concerning transport, annual inventories, safe handling and disposal, improved emergency response capabilities for handling spills, as well as plans for the construction of PCB destruction facilities. Recent inventories have revealed of the original 40,000 tonnes of PCB's imported into Canada only 24,000 tonnes can be accounted for. Of this, 61% is still in use in electrical capacitors, while the remainder (39%) is in storage awaiting disposal.

PCB'S WITHIN PRINCE EDWARD ISLAND

COMPANY	QUANTITY (LITRES)	LOCATION
In storage:		
CBC	4	Bonshaw Transmission Station
Charlottetown Water Commission	15	Charlottetown
CAPCC	46	Charlottetown
CHTN Broadcasting	2	Rocky Point
HW MacLaughlin Ltd(low level)	377	Charlottetown
Maritime Electric (pure)	364	Charlottetown
(mineral oil)	3483	Charlottetown
Newson Electric	10	Charlottetown
Acadian Sea Plant Ltd.	20	Naufrage
Parks Canada	5	Cavendish
P.E.I. Development Agency	2400	Georgetown
Summerside	90	
Transport Canada	75	Charlottetown
In use:		
CBC	2	Bonshaw
CEGF	682	Parkdale
Confederation Center	819	Charlottetown
Holland College	450	Summerside
Marine School	450	Summerside
Sullivan Building	818	Charlottetown
Towers Mall	773	Summerside
UPEI	3600	Charlottetown